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RCRA RECORDS CENTER

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INSPECTION OF GROUND WATER MONITORING PROGRAM NIXDORFF-LLOYD CHAIN COMPANY MARYVILLE, MISSOURI EPA REGION VII

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NIXDORFF-LLOYD CHAIN COMPANY

EPA REGION VII

This is to certify that I have reviewed this report and am in agreement with its findings and recommendations.

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CONTENTS

FIGURES

TABLES

SECTION 1

INTRODUCTION

The U.S. EPA Region VII has requested the assistance of GCA to conduct an inspection of the ground water monitoring program (40 CFR Part 265, subpart F) as implemented by Nixdorff-Metal Products Company at the Nixdorff-Lloyd Chain Company plant (NLCC) in Maryville, Missouri, EPA I.D. #MOD099238784.

The inspection conducted by GCA involved three phases:

- Document Review;
- Onsite Inspection; and
- Evaluation.

The document review was designed to determine compliance with the reporting and recordkeeping requirements of RCRA, and to evaluate the thoroughness and adequacy of the ground water monitoring program.

The onsite inspection evaluated the implementation of the ground water monitoring program and provided additional data to supplement those data obtained during the document review.

The final phase was an evaluation of the data obtained during the first two phases to provide an assessment of the facility compliance with 40 CFR 265, subpart F.

SECTION 2

FACILITY DESCRIPTION

LOCATION

Figure 1 shows a portion of the Maryville, MO USGS 15-minute quadrangle (1943) indicating the location of the facility as SE 1/4, SE 1/4, SE 1/4, SW 1/4, Section 16, Township 64N, Range 35W.

FACILITY OPERATIONS

Nixdorff-Lloyd Chain Company manufactures bulk chains from metal rods for hardware chain, automobile and truck tire chain. A pickling liquor and electroplating process was used in the past to treat the metal after which the spent pickling liquor, electroplating bath sludge and stripping and cleaning solutions were disposed of in their open lagoon. The lagoon is approximately 1.30 acres in size with a total depth of 5 ft and a present volume of between approximately 550,000 to 850,000 gallons. The installation of a clay liner was never completed for this surface impoundment. The plating process has not been in operation since 1981 and spent pickling liquor has not been dumped since October 14, 1981. The pickling liquor level was approximately 3.5 to 4 ft below the top of the dike surrounding the surface impoundment during the GCA inspection of September 21, 1984. Nixdorff-Lloyd plans to install a wastewater treatment facility to treat the wastes in the lagoon. The May 31, 1984 Missouri Department of Natural Resources RCRA inspection report recommended that Nixdorff-Lloyd Chain Company close the surface impoundment.

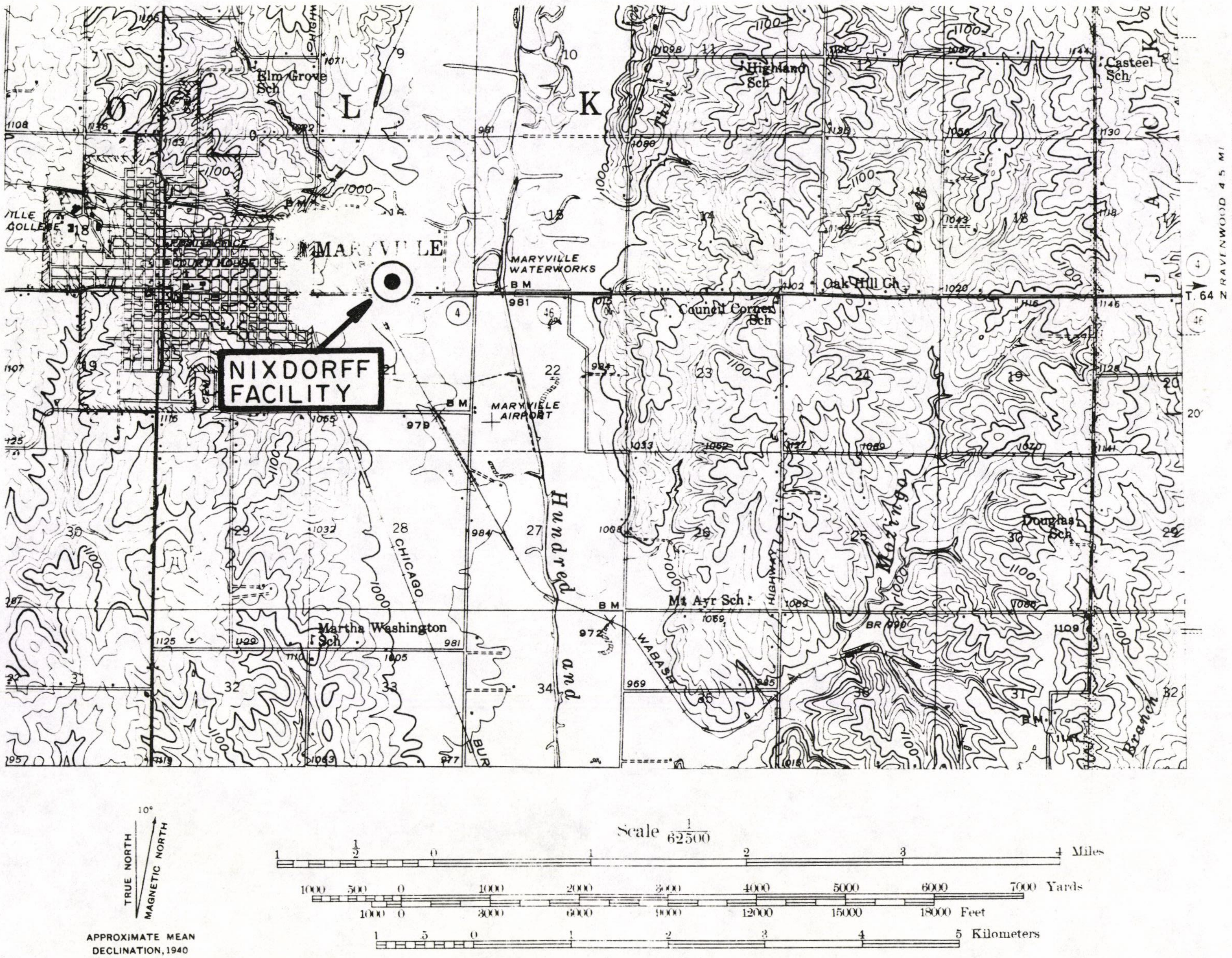


Figure 1. Topographic location of Nixdorff facility.

REGIONAL HYDROLOGY AND GEOLOGY

Nixdorff-Lloyd Chain Company lies in the Nodaway County of Northwestern Missouri on moderately dissected till plains. The site lies within the floodplain of the One Hundred and Two River drainage basin. This basin has a drainage area of 500 square miles at Maryville, Missouri. Overlying the bedrock are deep loess and glacial drift deposits ranging from approximately 20 to 230 ft in thickness. Sedimentary rocks including limestone and shale of Pennsylvania Age underlie these thick surficial deposits. The glacial drift of Northern Missouri is generally composed of relatively impermeable sandy clay till. In extreme northern Missouri sand and water-bearing channel-fill sand deposits are encountered as well as buried valleys and sand gravel deposits in northwestern Missouri. A complex system of buried valleys underlie the settlements of Maryville, Bedison, Conception Junction and Clyde in Nodaway County. (Groundwater Resources of Nodaway County, MO, MDNR, WRR No. 16; 1959.)

A typical northern Missouri profile of surficial deposits may be comprised of the following:

Depth (ft)	Overburden type
0-15 ($\pm$1)	Modified loess cover potential perched water table
15-25 ($\pm$1)	Gray clay potential perched water table
25-80 ($\pm$1)	Sandy clay (glacial till)

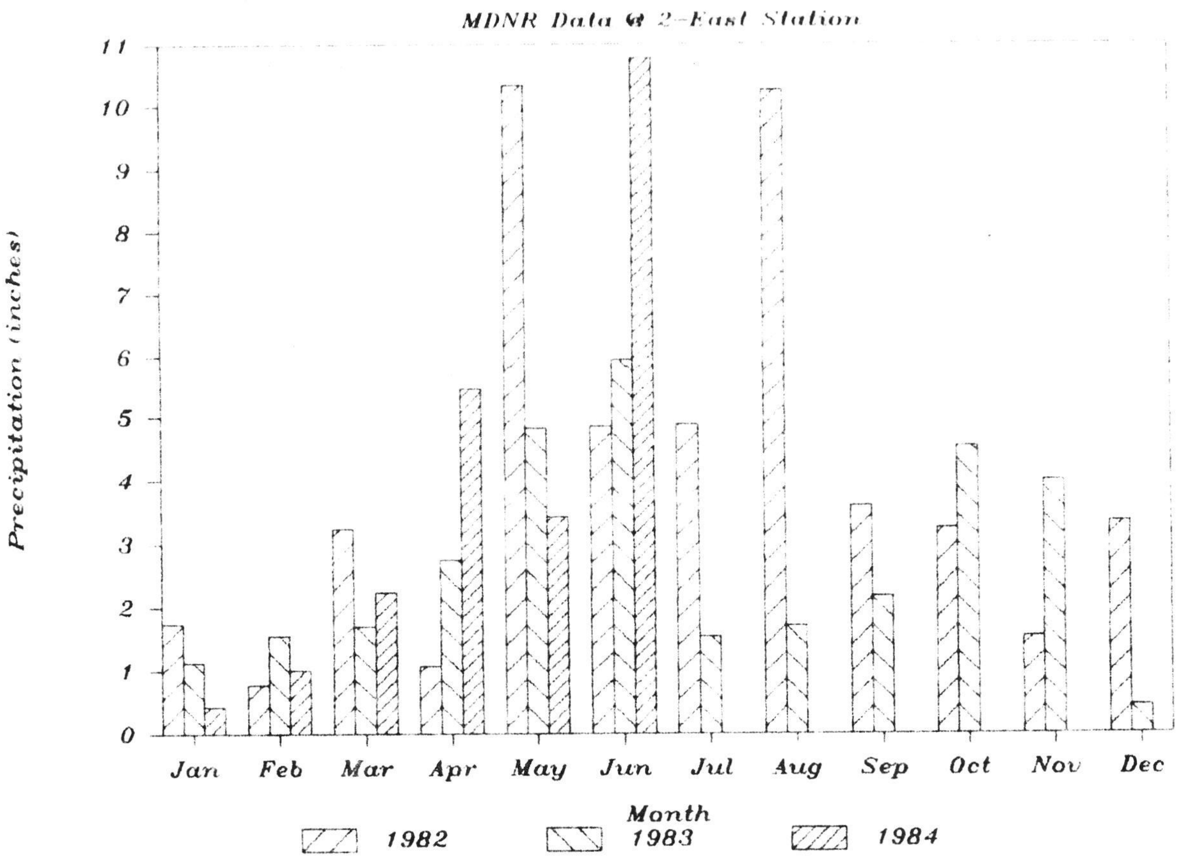
On steeper slopes the clay layer may be totally absent with loess lying directly on the till layer. A perched water table can develop at the contact of either sequence of deposits. The till may be well jointed throughout the vertical profile. Buried pre-glacial valleys or channels provide the best water yields to wells in unconsolidated aquifers. Yields in unconsolidated aquifers range between 2 to 500 gallons/minute. Recharge for these buried channels include storm drainage, infiltration through surficial deposits and recharge ascending from confined (bedrock) aquifers. Artesian conditions can exist in deeper wells in glacial drift deposits. (Geologic Aspects of Hazardous-
Waste Isolation in Missouri MDNR Engineering Geology Report No. 6 1981.)

The annual infiltration estimation for the One Hundred and Two River Watershed is 3.1 in. (Missouri Geological Survey and Water Resources Report #28). The average annual precipitation (1941-1980) for this region is approximately 34 in. The (1956-1970) average annual "free water surface evaporation" (term meaning evapotranspiration and pan evaporation) is approximately 40 to 42 in. Therefore, combining evaporation potential with precipitation averages shows a negative range of (-6 to -8 in.) for this region (see Figure 10 of Climatic Atlas for Design of Land Application Systems, MDNR, WP84-IG January 1984) in Appendix A. Figure 2 demonstrates the occurrence of sporadic and highly variable precipitation totals during the years of 1982, 1983, and partial 1984. This data provides evidence of potential partial drought and flooding over successive years. Therefore, annual recharge of ground water from precipitation can be highly variable, resulting in seasonal ground water table fluctuations.

SITE GEOLOGY AND GROUND WATER HYDROLOGY

The Nixdorff-Lloyd Chain Company is located on the north side of Highway 136 hear the western edge of the One Hundred and Two River floodplain (see Figure 1).

The surface soil onsite consists of a silty loam and a very silty clay (loess). Permeability of this top soil has been estimated to be 10^{-7} cm/sec by Dr. J. Hadley Williams (MDNR). The underlying deposits are highly variable in permeabilities and thickness. Several perched water tables can occur in this modified loess/glacial till depositional environment. Water was encountered at relatively shallow depths during RCRA monitoring well installations on June 6, 1982. Test hole reports by Layne-Western Company (1970) encountered gray clays to silty gray clays until 19 ft below ground surface (bgs). Between 19 and 27.5 ft bgs, a water-bearing zone of gray fine to coarse sands and some gravel was reported. Further exploration indicated less permeable materials of gray sandy clays below 27.5 until a hard, gray limestone-shale bedrock was penetrated from 86 to 90 ft (bgs). The RCRA monitoring wells have a maximum depth of 23 ft and extend just into the water bearing sands described above.



Month	1982	1983	1984
Jan	1.74	1.13	0.42
Feb	0.78	1.56	1.01
Mar	3.25	1.7	2.24
Apr	1.07	2.75	5.45
May	10.34	4.82	3.43
Jun	4.86	5.94	10.77
Jul	4.89	1.55	
Aug	10.25	1.72	
Sep	3.6	2.17	
Oct	3.24	4.53	
Nov	1.55	4	
Dec	3.35	0.44	
Totals	48.92	32.31	23.32

Figure 2. Maryville monthly precipitation totals.

The Nixdorff-Lloyd Chain Company water supply well #2 located on the north side of the plant building is within 400 to 600 ft radius of the RCRA wells and surface impoundment (see Figure 3, Facility Plan Map). Well yields for pumping of both wells (north and south) were noted to be 25 to 50 gallons/minute each according to facility personnel and Layne-Western Co., 1970 (see Appendix A). Previous inspection reports have indicated the possibility of the pumping wells influencing drawdown in the RCRA monitoring wells.

DOCUMENT REVIEW

The ground water monitoring program was described in a series of documents submitted to EPA on June 25, 1982 by Mr. Edmund Hughes, Project Engineer, Nixdorff-Lloyd Chain Company, St. Louis, MO 63178. The information contained in the submittal detailed the program and was sufficient to allow for an independent assessment of the program adequacy. The submittal included:

- A Ground Water Sampling and Analysis Plan;
- A draft Ground Water Quality Assessment Plan;
- A rough draft facility site plan with well locations;
- Supply well exploration logs provided by Layne Western Company, Inc. showing screened intervals;
- Soil boring logs;
- Ground water depth data; and
- All available ground water sampling results.

The primary deficiency in this submittal was a lack of surveyed well casing or ground water elevations.

Based on this information, monitoring well placement, depth, construction and sampling techniques appeared adequate as described, pending onsite inspection.

Ground water monitoring data were submitted for samples collected on July 14, 1982, October 14, 1982, January 13, 1983 and July 13, 1983. This data represents the first four quarters of monitoring as required by 40 CFR

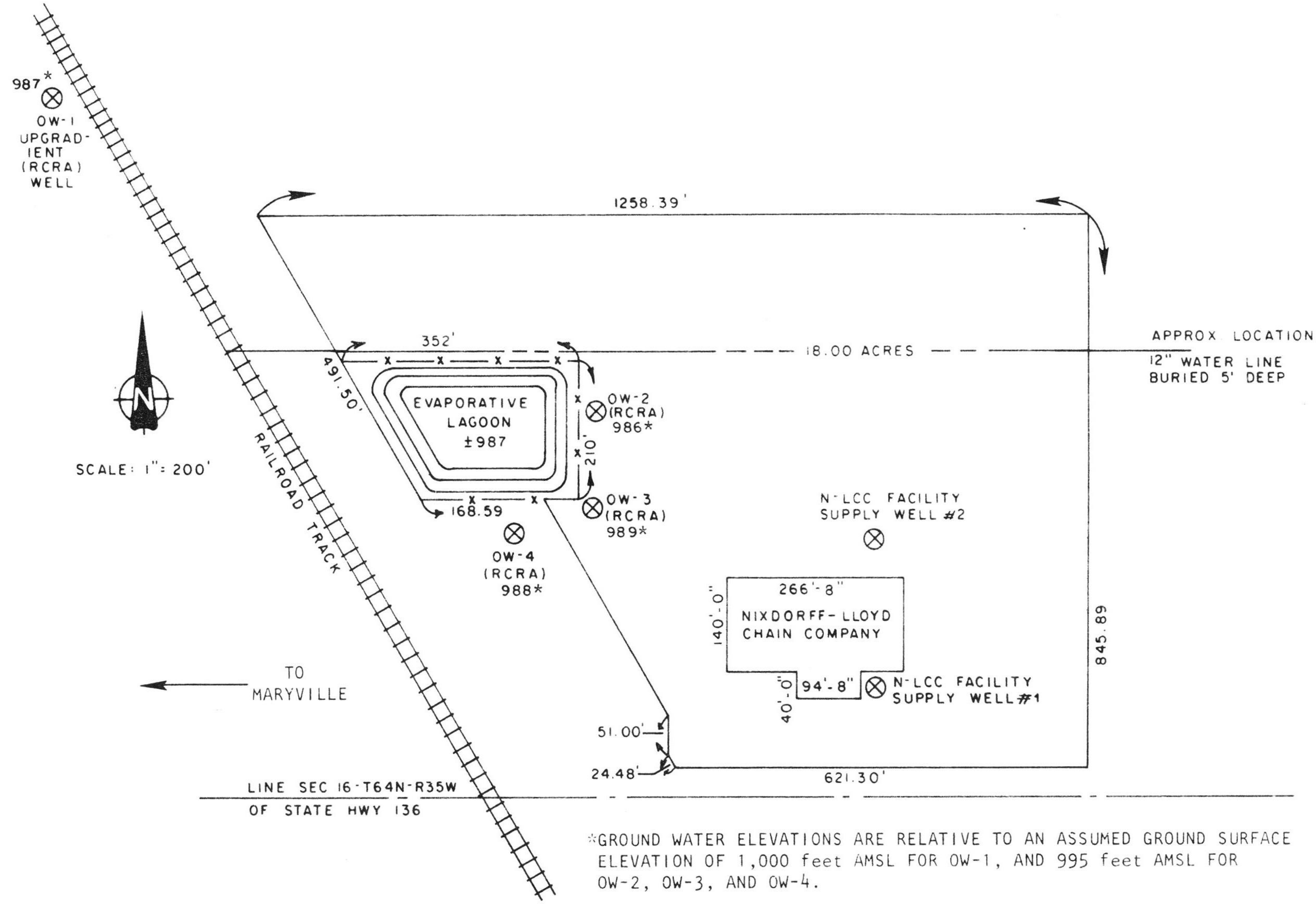


Figure 3. GCA audit measurements of ground water elevations at RCRA monitoring wells, 9/21/84.

data represents the first four quarters of monitoring as required by 40 CFR 265.93. It should be noted that the sampling and analysis was not conducted on a true quarterly basis and in fact no samples were collected representtive of springtime conditions. The submitted four data sets would in effect skew the background results toward dry season conditions. The facility also submitted a semiannual report based on the results of sampling conducted on August 25, 1983. These samples were collected only 1 month after the fourth quarter samples in July 1983 rather than 6 months later as implied by semiannual results. The submittal available to GCA did not include statistical analysis as required by 265.93. However, this statistical analysis is alluded to in the July 10, 1984 letter from Arthur H. Groner, Missouri Department of Natural Resources to Mr. R. H. Lochman, Nixdorff-Lloyd Chain Company.

The previously mentioned correspondence also points out several other deficiencies in the submitted semiannual and annual reports. Primarily these are a failure to determine actual ground water elevations as required under 265.92(e) and general failure of the facility to pursue the results of their "t" tests into the assessment phase as required by 265.93.

Subsequent to this correspondence, however prior to GCA's inspection, Nixdorff-Lloyd Chain Company's Maryville facility was purchased by LaClede Chain Company. The proceedings involved in this sale and their effect on the above-mentioned violations are not documented in the file information available to GCA during this inspection.

SECTION 3

ONSITE INSPECTION

GENERAL

On September 21, 1984, Mr. Paul Turina and Mr. Benjamin P. Berrios of GCA/Technology Division, Bedford, Massachusetts, inspected the Nixdorff-Lloyd Chain Company (NLCC) plant in Maryville, Missouri to determine NLCC's compliance with RCRA interim status ground water monitoring requirements.

The physical inspection was led by Robert N. Schulte (President), James Sears of Nixdorff Metals Corporation, and their Engineering Consultant, Edmund Hughes. Mr. Millard Stone of U.S. EPA and John Schofield of the Missouri Department of Natural Resources also accompanied GCA personnel throughout the day's activities.

The onsite inspection consisted of four elements:

- A physical inspection of the RCRA monitoring wells;
- A verification of the RCRA monitoring well locations;
- Audit measurements of the RCRA wells for total well depth; depth to water; and at two locations, conductivity, pH, and temperature of the groundwater; and
- Monitoring Program discussions with facility personnel.

PHYSICAL INSPECTION

The physical inspection of the four RCRA wells required an assessment of the adequacy of their construction and maintenance, and included a photograph of each well head. The photographs were taken with an Olympus "Quick Flash" 35 mm camera and Kodak VR 100 color print film. The photographs are included in Appendix B.

The ground water monitoring well OW-1 designated the upgradient well was found to have a questionable concrete collar or grout around the 6 in. diameter steel guard pipe. The separation of the outer protective pipe and grout has created a gap between surface soils and the cement seal providing a potential pathway for surface water into the borehole. The well itself is also situated in a depression with borehole material mounded up 6 to 8 in. around the well. This provides a catch basin for surface water and other potential materials from the Highway Department (i.e., road salts, etc.) that lies just to the south of the well (see photograph with Highway Department in background). Good well construction practice should include a concrete collar (sealed) around the guard pipe sloping away and down to ground surface. This practice should be instituted at all four RCRA well locations.

The well construction details provided in the Layne-Western report are summarized along with GCA's observation in the Observation Well Construction Summary Forms included in Appendix C.

WELL LOCATION VERIFICATION

Well locations were verified by triangulation and observation with respect to adjacent identifiable landmarks. A Brunton® compass was used along with an optical range finder to obtain up to three bearings/distances for each well. In a few instances, the distance to a known landmark was beyond the range of our instrument. In this case, one or two bearings/distances were utilized with a third shot consisting of a bearing only. Figure 3 shows the location of the monitoring wells and the evaporative lagoon. Well OW-1 upgradient was especially difficult to triangulate off the provided facility plot for the following reasons. This upgradient well is off the facility property with a railroad grade and trees separating it from view of the plant facilities which are the only landmark to tie sightings into, other than the railroad right-of-way. Sightings were made to the Highway Department buildings and storage tanks, but they have not been surveyed onto the facility site map or the USGS (1940) 15-minute quadrangle of Maryville, Missouri. Consequently, only OW-2, OW-3, and OW-4 wells were surveyed onto a landmark and verified to be within the accuracy of the compass and range finder.

AUDIT MEASUREMENTS

The depth to static water level and total well depth of all four RCRA wells were measured by electronic water level marker and double checked with a 100 foot steel tape. This data is summarized in Table 1. A comparison with audit measurements and the as-built typical construction detail (see Appendix) indicates that silting in of the screen at depth has occurred to a significant degree (in excess of 2 ft) in the downgradient well OW-3. A small pumping test and ground water quality sampling of four parameters was conducted on OW-1 (upgradient well) and OW-3 (downgradient well). The purging and monitoring procedures employed by GCA are presented in Appendix D, Standard Operating Procedures. The procedure used for the pump test and obtaining ground water measurements involves the use of a submersible, compressed air driven, bladder type pump. The pump discharges into a flow through cell containing sensors and electrodes for monitoring temperature, conductivity and pH. The monitored parameters, drawdown and recovery data as well as other pertinent information is recorded on the Ground Water Monitoring Report Forms included in Appendix E.

HYDRAULIC CONDUCTIVITY TEST

The recovery data measured by GCA (see Ground Water Monitoring Report Forms in Appendix B) for wells OW-1 and OW-3 was sufficient to provide a rough estimate of in situ hydraulic conductivity (permeability) at the respective wells to be 2 to 4 ft/day or 7×10^{-4} through 1.4×10^{-3} cm/sec, adjusted for the measured length of screen interval exposed to the aquifer.

Recovery rates were measured as soon as possible after pumping termination to apply a Hvorslev interpretation (see Hvorslev Method, Ground Water, Freeze and Cherry, 1979) of piezometer recovery data. Hydraulic conductivity can be computed by graphical plot of a ratio of water levels versus time since pumping termination. The reported range may be slightly biased and in error for two reasons. This type of pump and slug testing is highly dependent on a high quality piezometer intake. Monitoring well OW-3 was found to have in excess of 2.0 ft of silting in of well screen which is 20 percent of its piezometer intake. This fact was taken into account when

TABLE 1. RCRA MONITORING WELL AUDIT MEASUREMENTS

Monitoring well No.	Well status	Photo No.	Total depth (measured) (ft)	Design depth[a] (ft)	Static water level (ft) (measured)[b]	Thickness of silt[c] (ft)
OW-1	RCRA	1	21.55	20.50	12.95	-1.05
OW-2	RCRA	2	22.60	20.50	8.94	-2.1
OW-3	RCRA	3	18.25	20.50	6.15	2.25
OW-4	RCRA	4	20.38	20.50	6.98	0.12

[a]Designed depth on as-built construction details (see appendices).

[b]Audit Measurements by GCA, September 21, 1984. Static water levels below top of casing; true elevations of top of casing were not available in reports. The relative elevation of ground surface is implied to be less than 5 feet lower at RCRA OW-2, OW-3, and OW-4 downgradient versus OW-1 upgradient (in Ground Water Monitoring Compliance Inspection Report, August 20, 1982).

[c]The measured amount of thickness of "silting in" of a 10 foot length of screen.

calculating for hydraulic conductivity (K). The other main assumption for this analysis is that a piezometer is in a homogenous, isotropic medium in which soil and water are incompressible (Freeze and Cherry Ground Water, 1979, pp. 339-342).

GROUND WATER QUALITY TEST

Monitoring well OW-1 (upgradient) was purged for 14 minutes with a total volume of water removed of 2.25 gallons or 39 percent of water volume in the monitoring well. Initial pH at 2 minutes was 6.30, specific conductance 450 μmhos/cm, and temperature 14°C. After 13.5 minutes of pumping, pH was 6.88, specific conductance of 525 μmhos/cm, and temperature at 13°C. The pump intake was set near the bottom of the well screen to maximize aquifer water being pumped and to keep the pump totally submerged throughout the tests. As outlined below, audit measurements are compared to the facility reported range.

OW-1 (upgradient)	Audit value	Facility reported range
Depth to water	12.95 ft	3.8 - 9.9 ft
pH	6.88	5.8 - 7.2
Conductivity	525 μmhos/cm	170 - 460 μmhos/cm
OW-3 (downgradient)	**Audit value**	**Facility reported range**
Depth to water	6.15 ft	2.4 - 6.7 ft
pH	5.35	6.1 - 7.2
Conductivity	590 μmhos/cm	325 - 670 μmhos/cm

Monitoring well OW-3 (downgradient) was purged for 46 minutes with a total volume of water removed of 12 gallons or 1.46 well volumes. Initial pH at 2 minutes was 6.47, specific conductance of 650 μmhos/cm, and a temperature of 17°C. After 45 minutes of pumping, pH had declined to 5.35, specific conductance declined to fairly stable 590 μmhos/cm, and temperature at 15°C. Water level at 2.5 minutes after pumping termination was 9.39 ft and monitored periodically until full recovery at 6.15 ft. Recovery water levels can be found in the Appendix E labeled Ground Water Monitoring Report Form.

Audit measurements in comparison to July 13, 1983 data (KCTL) demonstrate a significant fluctuation of water levels in both OW-1 and OW-3, as well as conductivity. Measurements of pH were only significantly different for Well OW-3 (see Figure 4).

Water levels have significant fluctuations with time, due potentially from pumping of factory supply wells within 400 to 1,000 ft away from OW-2, OW-3, and OW-4 (see Figure 5). The close proximity of these downgradient wells to the surface impoundment may also be hydraulically influenced by the impoundment localized mounding of the water table. Local piezometric surface(s) onsite may be perched. Anomalous precipitation (as illustrated in Figure 2) during the time of observed water levels (1982 through 1984) could significantly influence a shallow, perched water table.

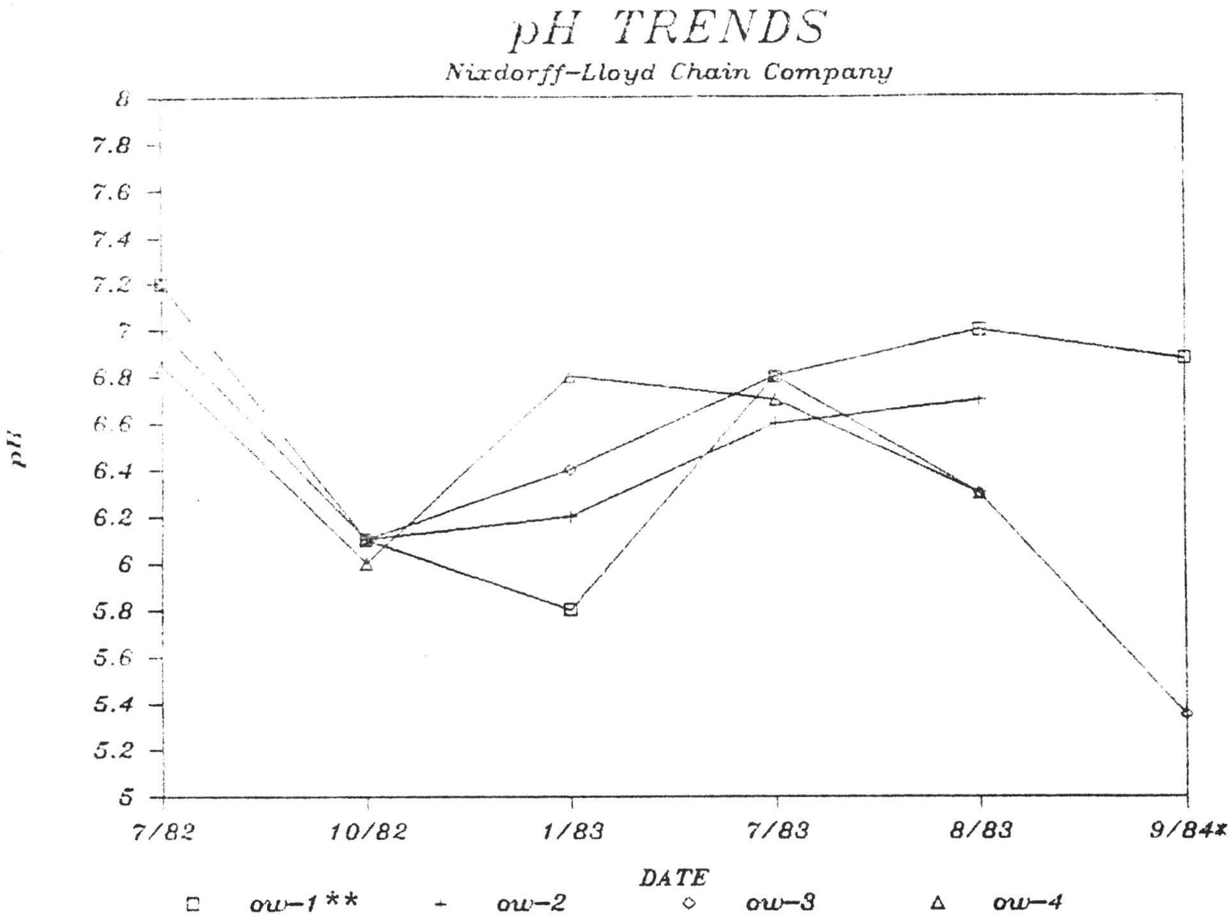
INTERVIEWS

No formal interviews were conducted during the onsite inspection of Nixdorff-Lloyd Chain Company. Brief introductions were exchanged between GCA personnel, State and Federal representatives, and the facility personnel. Physical inspections of the monitoring well construction and measurements were explained to Mr. James Sears as he accompanied the GCA field team throughout the days's activities.

QUALITY ASSURANCE/QUALITY CONTROL

All instruments utilized during the inspection were calibrated to the manufacturer's recommendations prior to use. The optical rangefinder and water level indicator were calibrated and cross-checked with a steel surveyor's tape (100 ft). The pH meter and conductivity meter were calibrated prior to each measurement in a certified buffer and standard conductivity solutions, as appropriate.

Audit checklists, included in Appendix F, were utilized to assure the completeness of the Inspection/Review.

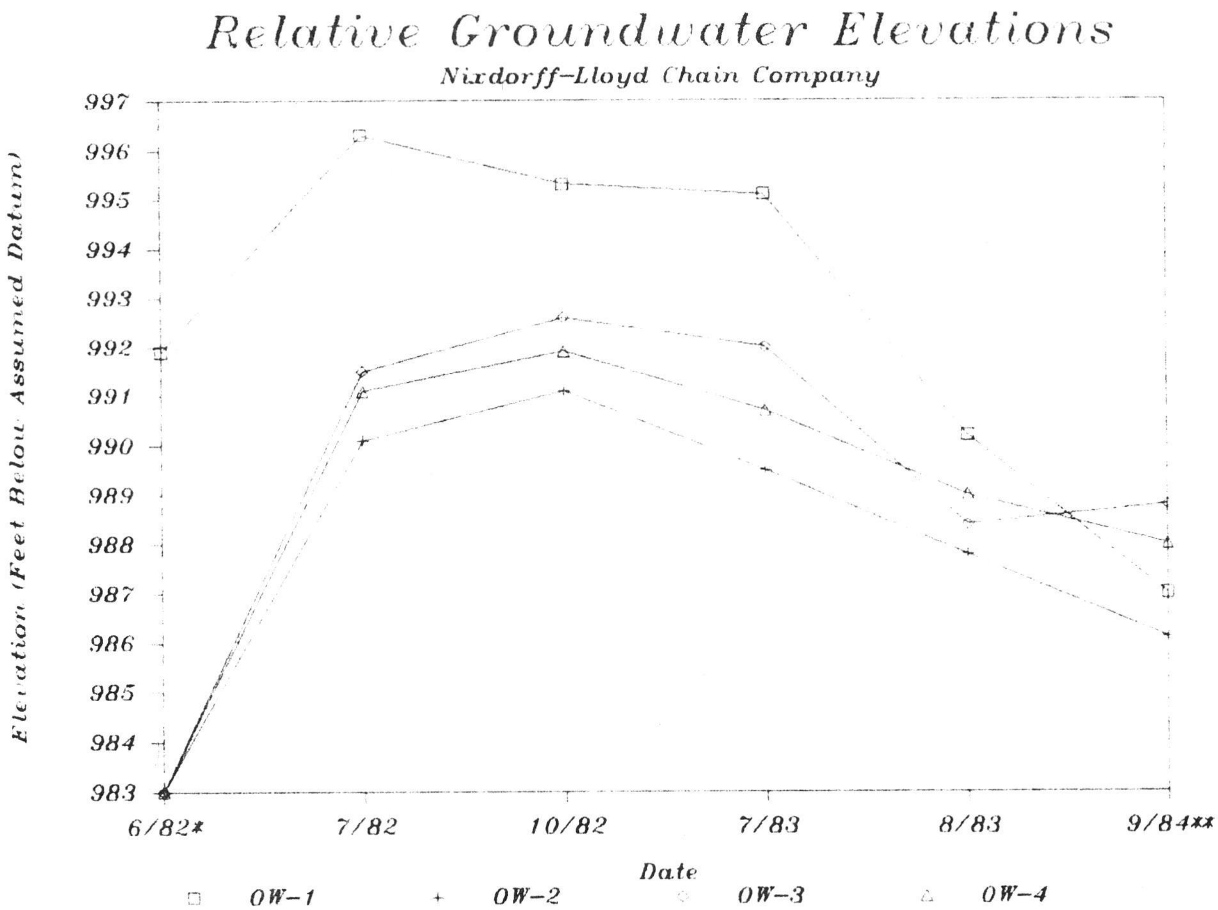


Date	Upgradient OW-1	Downgradient Wells OW-2	OW-3	OW-4
07/82	7.20	7.00	7.20	6.85
10/82	6.10	6.10	6.10	6.00
01/83	5.80	6.20	6.40	6.80
07/83	6.80	6.60	6.80	6.70
08/83	7.00	6.70	6.30	6.30
09/84	6.88		5.35	

*GCA Audit Measurements.

**OW-1 designated upgradient well.

Figure 4. Nixdorff-Lloyd Chain Company historical RCRA monitoring well pH results.



*Depth of water level encountered during well installation.

**GCA audit measurements.

Note: Ground water elevations determined by subtracting depth-to-water measurements from ground surface elevations indicated on USGS topographical map.

Figure 5. Nixdorff-Lloyd Chain Company historically recorded water levels.

SECTION 4

ASSESSMENT

After a thorough onsite inspection and review of facility plan, USGS 15 minute quadrangle of Maryville, Missouri, boring logs, previous ground water monitoring data reports, as well as correspondences between EPA, MDNR, and the facility project engineer, GCA assessed the ground water monitoring program at Nixdorff-Lloyd Chain Company. The location of the upgradient well appears to be in a topographically reasonable site. The lack of surveyed casing elevation for all four RCRA wells impeded the construction of a ground-truthed piezometric surface map. Although the local gradient could not be defined by a map of head level elevations, the documented information of pumping factory wells onsite at a rate between 25 and 50 gallons/minute could induce a gradient direction toward the factory wells. RCRA well elevations should have been surveyed prior to GCA document review and field audit measurements. Accurate well elevations are essential for proper hydrogeologic assessment of potential hydraulic gradients onsite. Figure 5 demonstrates a highly variable piezometric surface in accordance with variable recharge/discharge periods. Proper well location of all four wells may be questionable during these periods of highly variable precipitation and pumping regimes for the following possible reasons:

- The designated downgradient wells may not be intercepting all directions of local ground water flow if gradients fluctuate seasonally.
- The location of the lagoon on the floodplain may experience a localized reverse direction of ground water flow during high flooding of the One Hundred and Two River.
- The gradients have to be seasonally monitored to adequately assess the impact of the lagoon's wastes on the uppermost aquifer.

In accordance with RCRA compliance regulation 265.91(c), which states that all monitoring wells must be closed in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist.

A copy of the Layne-Western Company report (1970) is included as Appendix A. In summary of this report, the most suitable and only aquifer encountered during water well exploration on the north and south sides of the facility building was between 20 and 30 ft below ground surface. This defines the uppermost aquifer to be 20 to 30 ft (bgs). According to facility personnel and the Layne-Western Report (1970), the yield of the supply wells range between 25 and 50 gallons/minute per well. This water-bearing zone consists mainly of fine to coarse sands and gravel (see report boring logs). This zone would probably have been a better medium to screen the four RCRA monitoring wells into, and may possibly have reduced the silting in (≈2.0 ft) of OW-3.

This higher transmissive zone, which is being tapped by factory wells OW-1 and OW-2, may create a cone of influence as far as the surface impoundment and its proximal monitoring wells during extended pumping conditions without sufficient recharge to the aquifer. The location of the RCRA wells are in question as well as the depth of the well screen which could have been installed in the most transmissive aquifer zone to obtain more representative ground water samples, intercepting ground water flow potentially being induced to flow toward the factory pumping wells.

SPECIAL CONDITIONS

The location of the upgradient well OW-1 was as described by the facility map and relocated per direction of Dr. J. Hadley Williams of Missouri Department of Natural Resources, Rolla, Missouri. The well's proximity to the Highway Department make it susceptible to contamination from the salt piles, trucks, storage tanks, and other potential sources stored at this facility. Poor well construction interferes with accurate ground water quality measurements. Repair of the broken cement grout and sloping the grout away from the guard pipe would prevent potential pollution sources from entering the monitoring well borehole.

A review of the data available to GCA shows rather dramatic changes in monitored parameters. This is readily evident in the pH results as presented in Figure 4. Note particularly the changes that occur between July 1983 and August 1983 when OW-1 and OW-2 show an increase in pH and OW-3 and OW-4 show a decrease in pH. Similar erratic variations are evident in other parameters. This seems to further support the previously discussed contention that the wells are monitoring perched and not necessarily representative portions of the aquifer.

Additionally, "t" tests conducted by GCA on both the data submitted by Nixdorff-Lloyd as their first semiannual report (August 1983) and the audit values measured by GCA (September 1984) show statistically significant variation on several parameters. The "t" test data are included in Appendix H.

Similar "t" test results are cited in the correspondence from Arthur H. Groner, Missouri Department of Natural Resources to Mr. R. H. Lochman of Nixdorff-Lloyd. The letter also indicates several data gaps which would have an impact on the results of the statistial tests. Among these are missing specific conductance results from the first quarter monitoring. GCA calculated the mean of the second, third and fourth quarter results and used this value for the first quarter result in the subsequent statistical tests. Additionally, the facility submitted only the mean and variance of the analytical results for each parameter each quarter, rather than the required quadruplicate results. The actual variance for the population of results can only be estimated from the variance of a subset. GCA developed this estimate of the variance according to a method described in Introduction to Statistical Analysis, Dixon, W. J. and Massey, F. J., McGraw-Hill, 1969.

The following equation was used:

$$S^2_{Pop} = \frac{(n_1 - 1)\, S_1^2 + (n_2 - 1)\, S_2^2 \ldots + (n_k - 1)\, S_k^2}{n_1 + n_2 + \ldots n_k - k}$$

where: S_{Pop} = the estimated variance of the population

n = the number of elements in the sample set

S^2 = the variance of the sample set

k = the number of sample sets

The method utilizes the variability in the reported variance of each subset, in this case the reported variance for each of four quarters, to estimate the variance of the population (the unreported 16 results).

During this statistical evaluation, it became apparent that for the semiannual results at least, the facility had been calculating the sample variance by an equation different from that specified in Ground Water Monitoring Guidance for Owners and Operators of Interim Status Facilities, SW 963, March 1983. The facility reported variance was calculated by the equation:

$$S^2 = \frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n}$$

The previously mentioned guidance document recommends the following equation:

$$S^2 = \frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n - 1}$$

This difference in the denominator for "n weighting" instead of "n - 1 weighting" results in a smaller variance and may cause a false positive in the 't' test.

GCA utilized the required n - 1 weighting for the analysis presented in Appendix H, however the variance of the historic background values is estimated from facility reported variances, which may be in error. The 't' test results are summarized in Table 2. The validity of these results remains, however, in question.

GCA was unable to observe the ground water sampling procedures utilized by Nixdorff-Lloyd as those duties are being reassigned to a new staff member and the person previously responsible was not available on the day of the inspection. The sampling responsibility has shifted from various staff personnel at Nixdorff-Lloyd over the monitoring period. Considering that the sampling technique employed the use of bailers, the results of which are highly operator dependent, it is difficult to assess the impact on the reported data.

TABLE 2. STATISTICAL TEST SUMMARY

Nixdorff-Lloyd		pH	Cond	TOC	TOX	Total
5th quarter	MW-1	INC	INC	NC	INC	3
	MW-2	NC	INC	NC	NC	1
	MW-3	NC	INC	NC	INC	2
	MW-4	NC	INC	NC	INC	2
		1	4	0	3	8
GCA Audit*	MW-1	DEC	INC			
	MW-3	NC	INC			

INC = Statistically significant increase.

NC = No change.

DEC = Statistically significant decrease.

*MW-2 and MW-4 were not audited by GCA and the only measurements conducted at MW-1 and MW-3 were pH and conductivity.

It is evident that the facility should, as cited in the previously discussed correspondence, be in the ground water quality assessment phase as required in 40 CFR Part 265.93.

RECOMMENDATIONS

Well installation depths of all four monitoring wells are potentially not sampling the complete thickness portion of the uppermost aquifer as discussed previously under Assessment. A possible solution to detect the potential threat of contaminant migration below the monitoring wells in the more transmissive deposits would be to quarterly or periodically sample the factory supply wells for all parameters of concern, especially during extended periods of pumping for facility use. Another monitoring system improvement would be to deepen OW-3 to install a well screen in the more transmissive zone between approximately 20 to 30 ft (bgs). The evaluation of gradient fluctuations could include a careful monitoring program of all head levels (i.e., factory wells #1 and #2; OW-1, OW-2, OW-3, OW-4; and surface impoundment) throughout an extended factory well pumping regime.

This piezometric head data could then be used to compile a piezometric contour map for an assessment of the local hydrogeology and the potential influence of pumping the factory wells on the surface impoundment and its monitoring wells.

GCA agrees with the Missouri Department of Natural Resources recommendation of the closure of the Nixdorff-Lloyd Chain Company surface impoundment. The following are supporting evidence for closure:

- No liner of any type was installed in the lagoon.
- The physical properties of the surface soils in which the lagoon is situated provides inadequate plasticity to seal a liquid impoundment (pH = 1-3).
- Soil permeability exceeds the minimum requirements with a value of 10^{-7} cm/sec, increasing to 10^{-4} to 10^{-3} or potentially greater with depth.

- Historically ground water levels seasonally fluctuate significantly enough to rise above the level of the bottom of surface impoundment. Therefore, the surface impoundment may be hydraulically connected to the piezometric surface during/after excessive precipitation and recharge.

- GCA audit measurements comparing pH and specific conductance values to quarterly results demonstrate a significant decline in ground water quality in downgradient well OW-3.

- The "silting in" of OW-3 (downgradient) may cause inadequate sampling of the uppermost aquifer, therefore, not detecting contamination of appropriate flow zones.

- The close proximity of the facility's pumping wells to the unsealed surface impoundment could potentially provide a hydraulic connection between these facility components during extended pumping periods.

APPENDIX A

CLIMATIC ATLAS

MISSOURI DEPARTMENT OF NATURAL RESOURCES
Published by the Division of Environmental Quality
Water Pollution Control Program

Management Guide

WP84-1G

January 1984

CLIMATIC ATLAS

FOR DESIGN OF LAND APPLICATION SYSTEMS

PURPOSE

The one in ten year return frequencies for climatic data are the basis for design and evaluation of land application systems in Missouri. Average data are not reliable for planning a system because of the extreme variation from year to year. This report presents information in the form of tables and figures for selected return frequencies from daily to annual periods. Data is included for rainfall, runoff, evaporation, net rainfall minus evaporation, irrigation rates and temperature. Both average and one in ten year frequencies are presented for comparison.

TABLE OF CONTENTS

*Reference sources for tables and figures are shown in parenthesis ( ) in text.

RAINFALL

Consider both short term "ten day" rainfall and long term "60-365 days" rainfall. The one in ten year "ten day" rainfall is a critical design factor because this is the minimum amount that must be stored before evaporation can be considered. The one in ten year "10 day" is three to four inches greater than the 25 year 24 hour storm. This 10 day rainfall event generally equals or exceeds the net 60 day rainfall minus evaporation. Compare Figure 1, 2, and Table 1.

TABLE 1 ONE IN TEN YEAR RAINFALL BY SEASON 1941 - 1970 *(1)*

INCHES

AVERAGE ANNUAL RAINFALL		ONE IN TEN MAY - OCTOBER					ONE IN TEN NOVEMBER - APRIL				
	365 DAYS	180 DAYS	120 DAYS	90 DAYS	60 DAYS	10 DAYS	180 DAYS	120 DAYS	90 DAYS	60 DAYS	10 DAYS
34 in.	44	28	23	19	15	8	15	12	11	10	7
36 in.	47	29	24	20	16	8	18	13	12	10	7
38 in.	50	30	25	20	17	9	19	14	13	12	7
40 in.	52	31	25	21	18	8-10	20	17	16	15	8
42 in.	55	32	27	22	18	8-10	22	18	17	16	8
44 in.	57	33	27	24	18	8	28	21	19	18	8
46 in.	60	36	27	25	19	9	32	22	20	19	8
48 in.	63	38	28	26	20	10	35	24	21	20	8

TABLE 2 NUMBER OF DAYS PRECIPITATION DURING ONE IN TEN YEAR RAINFALL YEAR (1941-1980) *(1)*

Location	Precipitation Days per Year Total Days		Days 0.1 inch or more
1. Bethany	150		75
2. Hannibal	153		83
3. Jefferson City	154		78
4. Farmington	154		82
5. Lebanon	155		86
6. Tarkio	156		71
7. St. Louis	158		78
8. St. Joseph	162		70
9. Joplin	162		70
10. Portageville	164		84
11. West Plains	166		84
12. Kansas City	168		73
13. Columbia	179		78
14. Springfield	179		78
Range	150 - 179	27	70-86
Median	160		78

Figure 1

ONE IN TEN YEAR : 10 DAY RAINFALL (9)

Inches 1941 - 1970

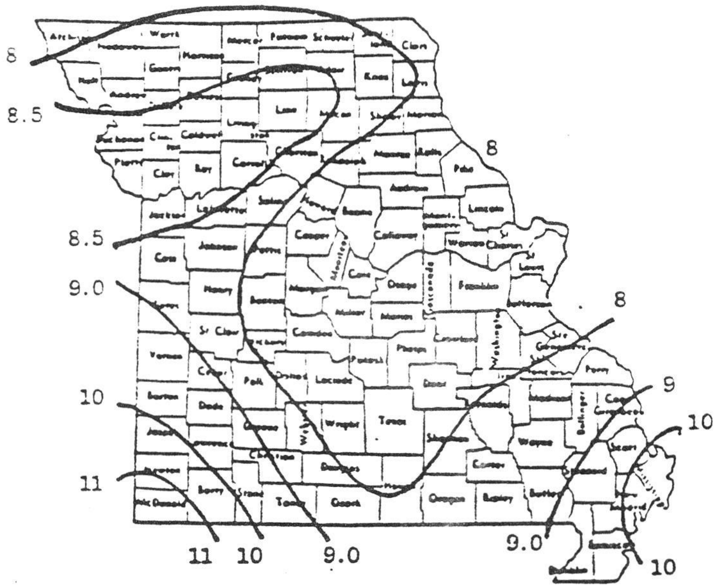


Figure 2

ONE IN 25 YEAR : 1 DAY RAINFALL, OR (9)
ONE IN TEN YEAR : 2 DAY RAINFALL, OR
ONE IN TWO YEAR : 10 DAY RAINFALL

Inches 1941 - 1970

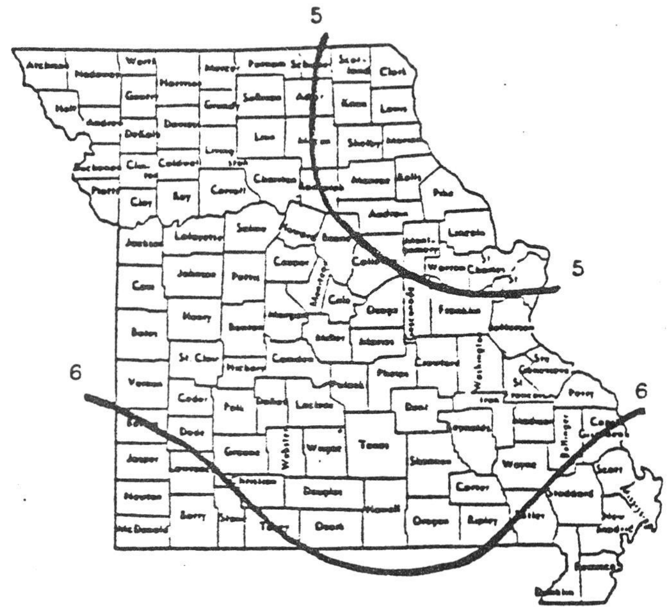


Figure 3

AVERAGE ANNUAL PRECIPITATION 1941 - 1980 (1)

Inches

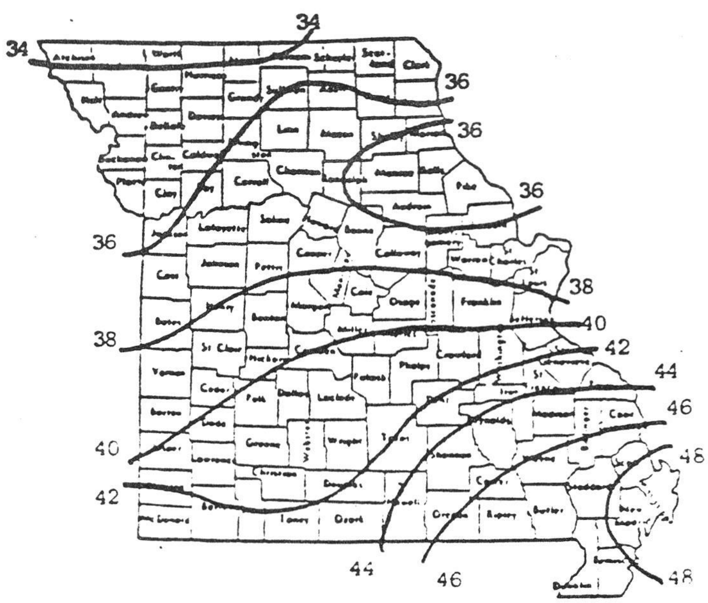


Figure 4

ONE IN TEN YEAR PRECIPITATION 1941 - 1970 (1)

Inches

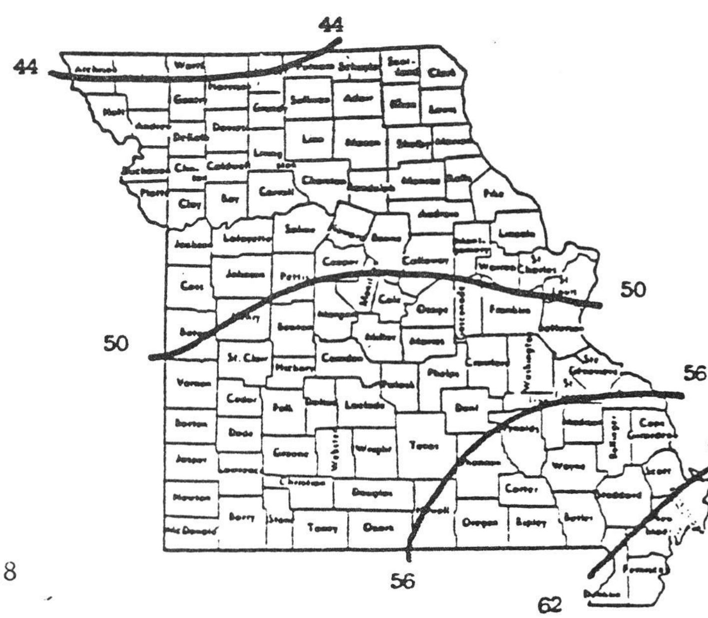


TABLE 3 AVERAGE MONTHLY PRECIPITATION (1)

INCHES 1941 - 1970

Missouri REGION	Annual	1 JAN	2 FEB	3 MAR	4 APR	5 MAY	6 JUNE	7 JULY	8 AUG	9 SEPT	10 OCT	11 NOV	12 DEC
North	36	1.2	1.2	2.4	3.4	4.4	5.7	4.0	3.8	4.0	3.0	1.5	1.4
Central	40	1.4	1.7	2.7	4.0	5.0	5.5	4.0	3.8	4.5	3.7	1.9	1.8
Southwest	42	1.8	2.3	3.3	4.3	5.3	5.0	3.6	3.2	4.5	3.6	2.8	2.[illegible]
Southeast	46	3.9	3.7	4.7	4.5	5.0	4.1	3.1	3.0	3.6	2.9	3.8	3.[illegible]

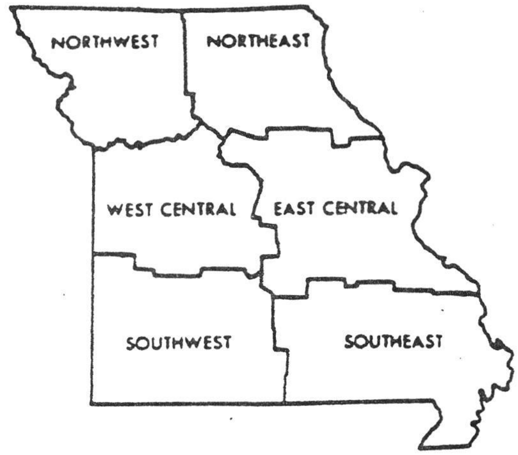
TABLE 4 MONTHLY PRECIPITATION FOR 1973 AND 1982 (1)

Missouri REGION	TOTAL 1973	JAN	FEB	MAR	APR	1973 MAY	INCHES JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
North	55.5	2.8	2.0	8.1	5.5	6.5	2.9	6.6	2.3	9.6	4.5	2.1	2.6
Central	54.0	3.4	1.5	9.8	7.1	5.1	3.6	4.8	0.8	6.2	4.4	3.2	4.1
Southwest	59.0	3.9	1.4	9.4	6.6	5.7	4.7	3.8	1.2	6.2	5.4	6.2	4.5
Southeast	67.3	4.4	2.1	8.6	10.8	9.6	4.1	2.9	3.0	3.0	2.5	10.6	5.7

Missouri REGION	Total 1982	JAN	FEB	MAR	APR	1982 MAY	INCHES JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
North	47.3	1.5	1.0	4.0	2.4	8.1	4.3	3.6	7.7	2.8	3.5	3.0	5.4
Central	52.3	3.8	0.6	3.1	2.5	4.9	6.2	3.9	9.2	5.0	2.2	2.9	8.0
Southwest	47.0	5.0	0.5	2.3	4.0	5.4	4.2	0.6	10.4	1.0	2.5	5.0	6.1
Southeast	64.0	5.5	1.7	2.8	5.4	6.6	5.4	3.0	11.4	4.7	4.1	3.0	10.[illegible]

TABLE 5 RANGE OF MONTHLY PRECIPITATION AMOUNTS (10)

INCHES, 1918 - 1961



TOTAL PRECIPITATION WHICH HAS BEEN EXCEEDED 10, 25, 50, 75, AND 90 PERCENT OF THE TIME, INCHES* •

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
NORTHWEST												
10%	2.6	2.2	4.0	6.2	6.9	10.3	5.2	6.4	8.1	5.0	5.0	2.7
25%	1.7	1.7	3.1	4.7	5.0	7.4	4.0	5.0	5.9	3.6	2.9	1.7
50%	1.0	1.1	2.0	3.0	3.7	5.3	2.8	3.9	4.1	2.1	1.9	1.1
75%	.7	.4	1.3	2.4	2.4	3.2	1.8	2.4	2.0	1.6	.9	.7
90%	.2	.2	.4	1.6	1.4	2.1	1.0	1.4	.8	.8	.4	.3
WEST CENTRAL												
10%	3.6	3.0	5.6	7.0	8.9	9.1	5.1	7.1	8.6	6.0	5.5	2.8
25%	2.2	2.0	3.8	5.1	6.0	6.8	3.8	5.4	6.9	4.3	3.4	2.4
50%	1.3	1.4	2.6	3.6	4.0	4.9	2.7	3.2	4.1	3.0	2.5	1.9
75%	.9	.9	1.6	2.6	2.6	2.8	1.3	2.0	2.6	1.9	1.4	1.2
90%	.4	.3	.8	2.1	2.2	1.4	.8	1.4	1.4	1.4	.6	1.1
SOUTHWEST												
10%	4.3	3.6	6.5	8.2	8.8	9.8	6.0	7.9	9.0	6.3	5.5	3.9
25%	3.0	2.2	4.0	6.1	7.0	7.2	4.1	5.4	6.6	4.8	4.1	3.0
50%	2.0	1.7	2.9	4.3	4.7	5.1	2.9	3.3	3.8	3.2	2.9	2.4
75%	.9	1.2	2.1	3.1	3.0	3.1	1.4	2.0	2.0	2.1	1.9	1.4
90%	.5	.4	1.3	2.1	2.0	1.4	.9	1.2	.9	1.6	1.1	.9
NORTHEAST												
10%	3.0	2.2	4.6	6.2	6.8	9.0	5.4	7.2	9.1	5.9	5.4	3.0
25%	2.0	1.8	3.8	4.8	5.0	7.0	4.1	5.8	6.0	3.9	3.8	2.2
50%	1.2	1.3	2.6	3.1	3.6	5.0	2.8	3.8	3.7	2.4	2.4	2.0
75%	1.1	.7	1.7	2.4	2.4	3.1	1.4	2.4	2.4	1.8	1.4	1.3
90%	.3	.4	1.0	1.7	1.6	1.7	.4	1.5	1.4	1.0	.9	.4
EAST CENTRAL												
10%	4.0	3.1	6.2	7.0	8.5	8.4	5.2	6.2	7.4	5.5	5.0	3.9
25%	2.7	2.7	4.0	5.4	6.7	6.8	3.8	5.1	6.0	4.0	4.0	2.9
50%	1.7	1.9	2.9	3.7	4.7	4.4	2.8	3.6	3.7	2.9	2.8	2.1
75%	1.2	1.3	2.1	2.4	2.8	2.9	1.7	2.1	2.2	1.8	1.7	1.4
90%	.5	.6	1.4	1.6	1.7	1.3	1.2	1.4	1.2	1.4	1.0	.3
SOUTHEAST												
10%	7.3	5.6	8.4	8.0	9.0	8.1	5.4	7.1	7.1	7.0	6.3	5.4
25%	5.0	3.9	6.0	6.1	6.7	5.8	3.8	5.0	5.3	4.7	5.0	4.1
50%	3.0	2.7	3.9	4.2	4.2	3.2	2.7	3.4	3.4	3.0	3.0	3.2
75%	1.8	1.6	2.4	2.7	2.7	2.1	1.6	2.3	1.8	1.9	2.1	2.4
90%	1.2	1.1	1.6	2.1	1.4	1.2	1.4	1.1	1.2	.9	1.4	1.6

*Note: Monthly values are listed as independent variables and can not be added to obtain annual precipitation amounts.

RUNOFF

TABLE 6 AVERAGE % RUNOFF - FEEDLOTS *(14)*
Concrete and Roof Areas

MO Region	Dec - Feb	Mar - May	June - Nov
North	40%	50%	60%
Central	50%	50%	60%
South	60%	60%	60%

TABLE 7 AVERAGE % RUNOFF - FEEDLOTS *(14)*
Earth Feedlot

MO Region	Dec - Feb	Mar - May	June - Nov
North	15%	20%	30%
Central	20%	25%	30%
South	25%	30%	30%

Figure 5

AVERAGE ANNUAL RUNOFF FOR LARGE WATERSHEDS *(15)*

Inches

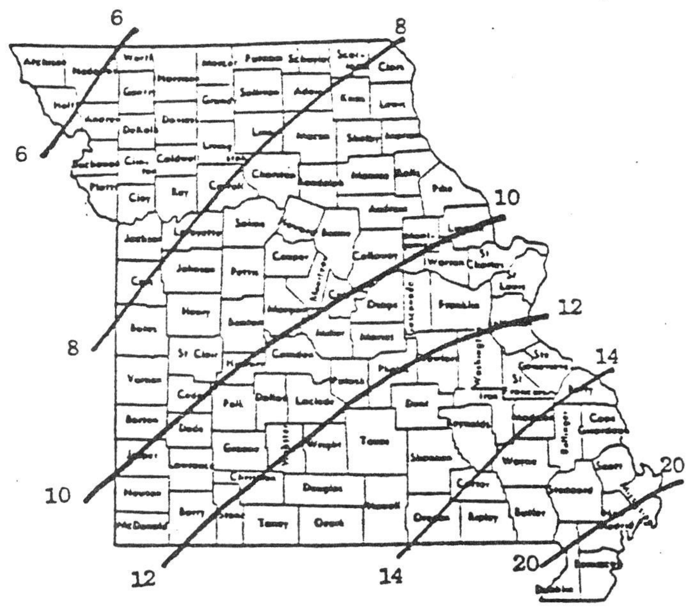


TABLE 8 RUNOFF - One year in ten - FEEDLOTS *(11)*

Feet/Year

	Average Annual Rainfall Area								
Type of Surface	32"	34"	36"	38"	40"	42"	44"	46"	48"
Earth areas (ft/yr)	1.5	1.7	1.8	2.0	2.2	2.5	2.7	2.8	3.0
Concrete/Roof (ft/yr)	2.8	2.9	3.1	3.3	3.5	3.6	3.8	4.0	4.2

TABLE 9 RUNOFF FACTORS* *(12)*

Days Storage	Runoff Factor All Areas
300 - 365	1.00
180	0.60
120	0.50
90	0.40
60	0.30

* Multiply factor times ft. of runoff from table 8

EVAPORATION

VAPORATION

TABLE 10 AVERAGE EVAPORATION* *(1)*

INCHES 1956 - 1980

MO REGION**	ANNUAL	1 JAN.	2 FEB.	3 MAR.	4 APR.	5 MAY	6 JUNE	7 JULY	8 AUG.	9 SEPT.	10 OCT.	11 NOV.	12 DE
North	38	0.2	0.3	2.5	4.0	4.5	5.6	6.2	5.5	3.7	2.8	2.5	0.
Central	39	0.2	0.3	2.5	4.0	4.6	5.9	6.5	5.7	3.8	2.8	2.5	0.
South	42	0.3	0.5	2.8	4.3	5.0	6.0	6.8	6.2	4.0	3.0	2.7	0.

* Free water surface evaporation estimates evaporation from either a lagoon, pond, lake, or vegetated land surface. It is obtained by adjusting Pan Evaporation using coefficients developed by the National Weather Service. Free water surface evaporation is the term now used by the National Weather Service to represent evapotranspiration from a completely vegetated land surface or from standing water in a basin.

TABLE 11 ONE IN TEN YEAR EVAPORATION* *(1)*

INCHES 1956 - 1980

MO REGION**	ANNUAL	1 JAN.	2 FEB.	3 MAR.	4 APR.	5 MAY	6 JUNE	7 JULY	8 AUG.	9 SEPT.	10 OCT.	11 NOV.	12 DE
North	30	0	0	2.0	3.2	3.6	4.6	5.0	4.4	3.0	2.2	2.0	0
Central	31	0	0	2.0	3.3	3.7	4.8	5.3	4.6	3.1	2.2	2.0	0
South	34	0	0	2.5	3.5	4.0	5.0	5.5	5.0	4.0	2.5	2.0	0

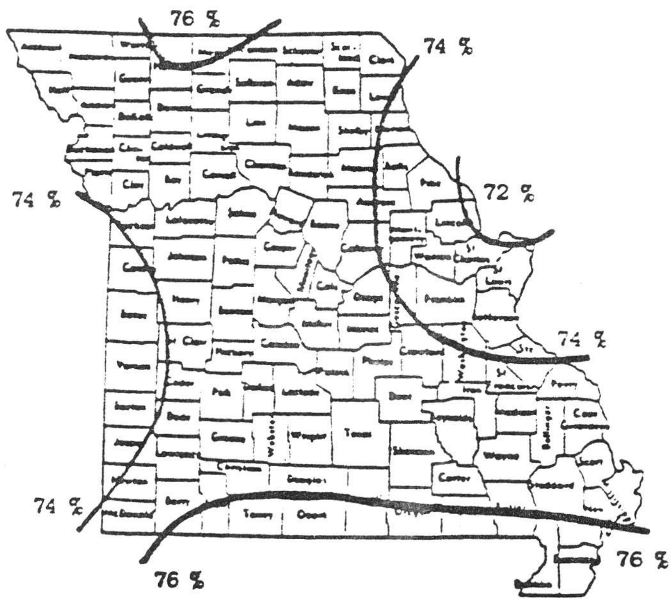
* Estimated evaporation during a ONE IN TEN YEAR RAINFALL

** Primary evaporation stations for each region: North - Spickard, Mo., Grundy County; Central - New Franklin, Mo., Howard County and Lakeside, Miller County; South - Mt. Vernon, Mo., Lawerence County.

EVAPORATION

Figure 6

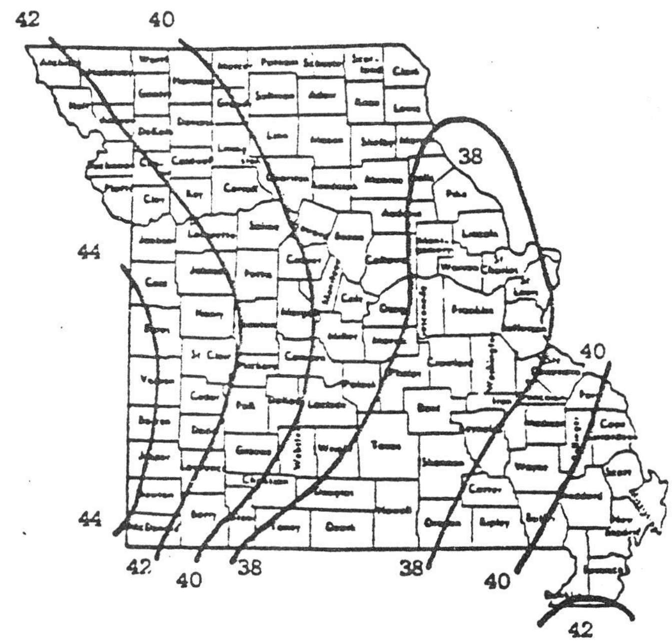
COEFFICIENTS TO CONVERT CLASS A PAN EVAPORATION
TO FREE WATER SURFACE EVAPORATION * (3)
MAY - OCTOBER



*Pan Evap. x % = Free Water Surface Evaporation

Figure 7

FREE WATER SURFACE EVAPORATION - ANNUAL * (3)
1956 - 1970
Inches



*Free Water Surface Evaporation = Evapotranspiration

Figure 8

FREE WATER SURFACE EVAPORATION NOV. - APRIL (3)
1956 - 1970
Inches

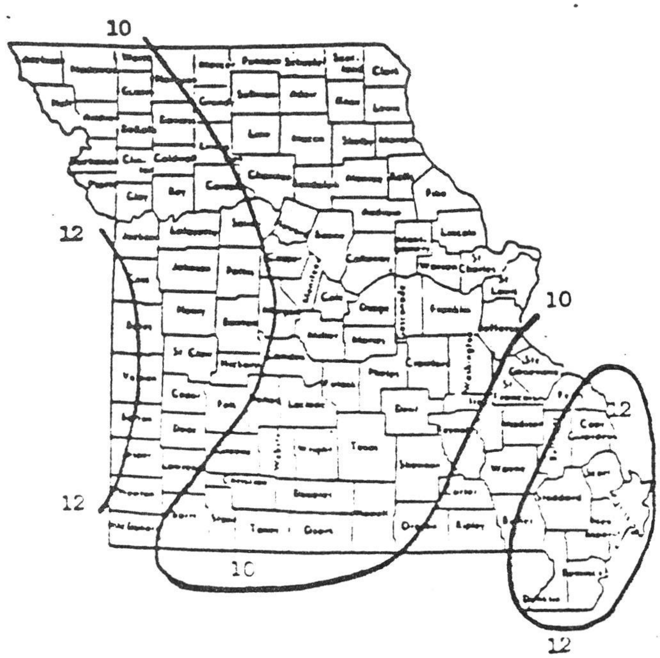
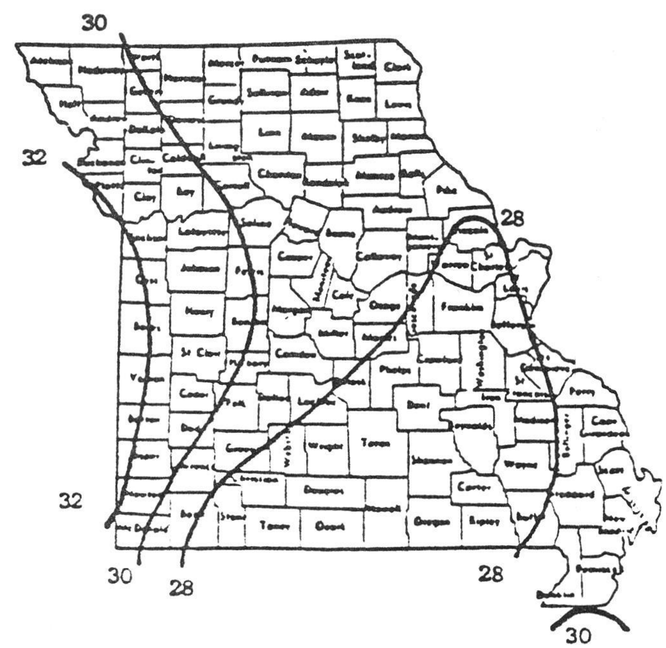


Figure 9

FREE WATER SURFACE EVAPORATION MAY - OCTOBER (3)
1956 - 1970
Inches



RAINFALL minus EVAPORATION

TABLE 12 ONE IN TEN YEAR RAINFALL MINUS EVAPORATION *(1)*
ANNUAL AND NOVEMBER - APRIL

INCHES 1941 - 1980

AVERAGE ANNUAL RAINFALL	365 DAYS	180 DAYS	120 DAYS	90 DAYS	60 DAYS	10 DAYS
34	14	10	8	8	8	8
36	14	10	9	8	8	8
38	17	11	10	9	9	9
40	19	12	11	10	10	8-10
42	22	14	13	12	10	8-10
44	25	21	18	15	11	8-10
46	28	24	20	17	13.5	9
48	30	27	22	18	14	10

Figure 10

AVERAGE ANNUAL
RAINFALL minus EVAPORATION 1941 - 1970 *(1)*
Inches

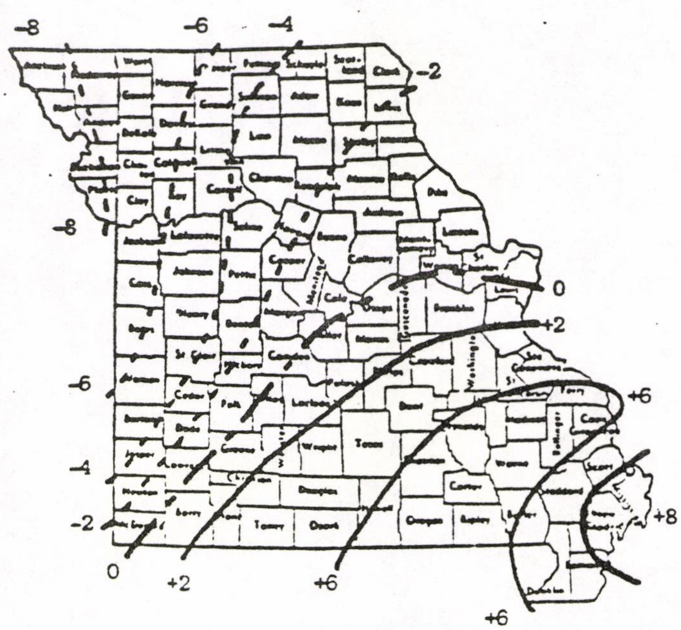
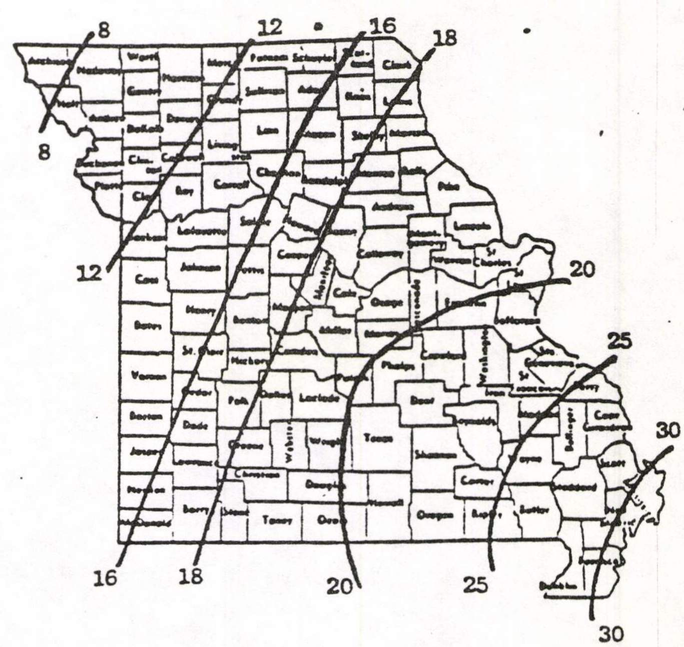


Figure 11

ONE IN TEN YEAR
RAINFALL minus EVAPORATION 1941 - 1970 *(1)*
Inches



RAINFALL minus EVAPORATION

Figure 12

ONE IN TEN YEAR :

60 DAY RAINFALL MINUS EVAPORATION 1941 - 1970 *(1)*

Inches

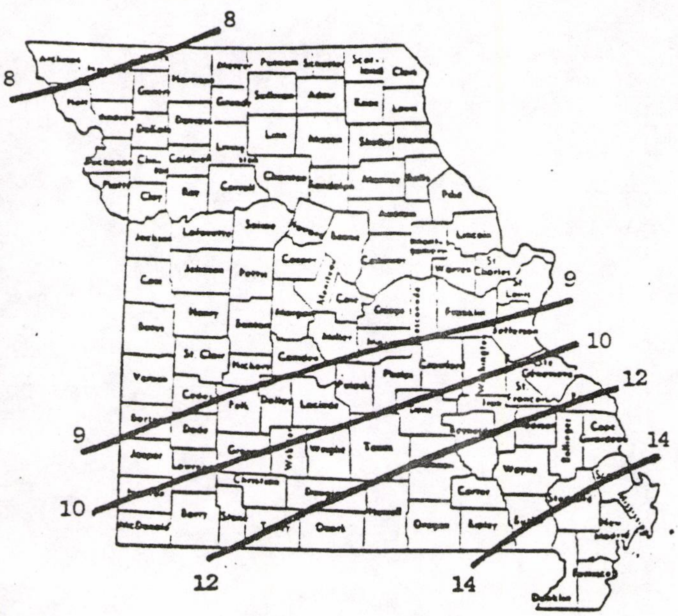


Figure 13

ONE IN TEN YEAR :

90 DAY RAINFALL MINUS EVAPORATION 1941 - 1970 *(1)*

Inches

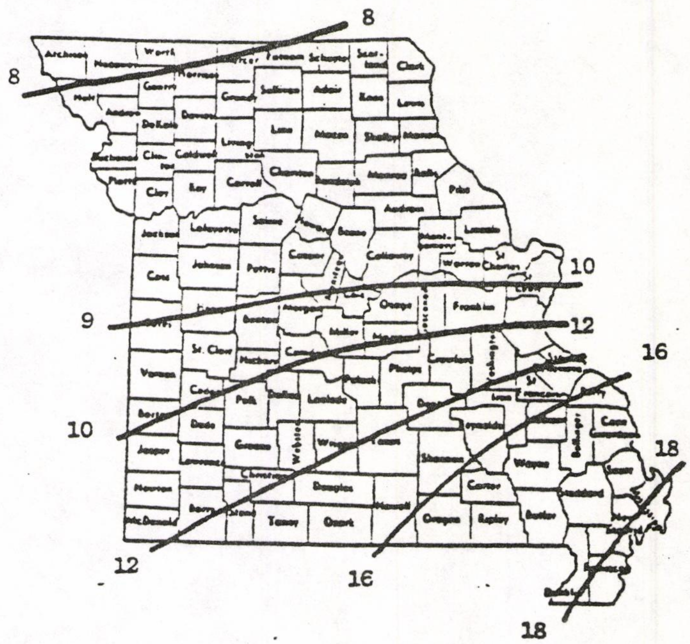


Figure 14

ONE IN TEN YEAR :

120 DAY RAINFALL MINUS EVAPORATION 1941 - 1970 *(1)*

Inches

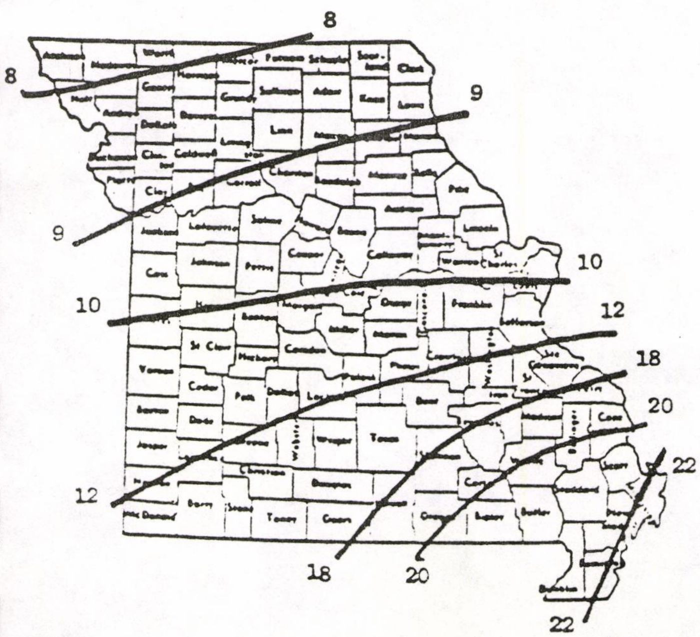
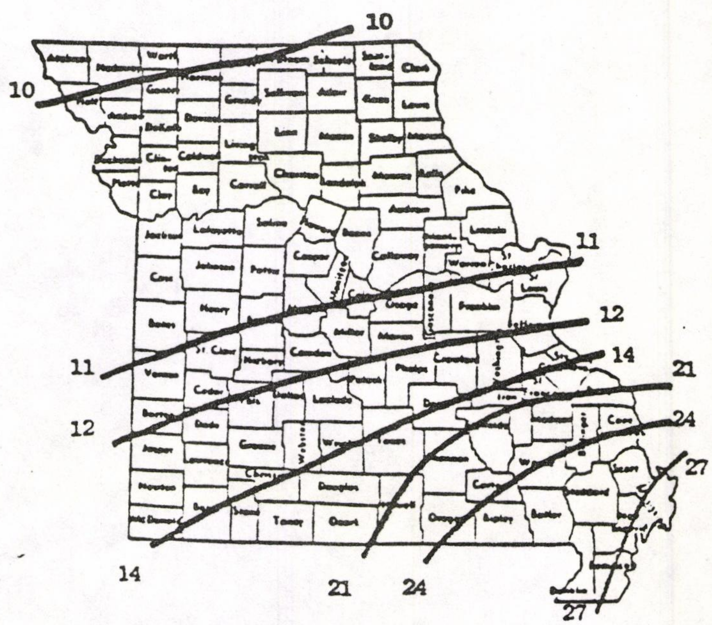


Figure 15

ONE IN TEN YEAR :

180 DAY RAINFALL MINUS EVAPORATION 1941 - 1970 *(1)*

Inches



IRRIGATION

TABLE 13 IRRIGATION DEFICIT FOR GRASSLAND* (10)

May 1 - August 31

	Irrigation Deficit, Inches		
Probability	Northwest Missouri	Central Missouri	Southeast Missouri
1 year out of 20	24.6	20	18.2
4 years out of 20	22.2	18	16.4
10 years out of 20	21.4	16	14.6
15 years out of 20	17.2	14	12.7
19 years out of 20	14.8	12	10.9

* These irrigation deficits were calculated on a continuous irrigation basis, applying water daily to bring the soil moisture content up to field capacity and allowing no time for drying periods or harvest. Annual irrigation deficits can also be calculated for management schemes in which the soil was allowed to dry until it had capacity for .5 inch, 1.2 inches, and 1.7 inches of additional water. For these management schemes, multiply the total irrigation deficit by .82 .65, and .55, respectively, to obtain the amount of water that can be disposed of.

TABLE 14 MONTHLY IRRIGATION DEFICIT OF GRASSLAND (10)
May - Aug

	Water required on indicated frequency of years			
	May	June	July	August
Three out of Four Years	2.4 in.	3.0 in.	3.7 in.	3.4 in.
Two out of Four Years	3.0	3.9	4.6	4.0
One out of Four Years	3.4	4.4	5.5	5.0

TABLE 15 AMOUNTS OF WATER THAT CAN BE APPLIED TO SOILS FOR WASTEWATER TREATMENT UNDER TYPICAL MANAGEMENT.* *(10)*

Soil Permeability Class	Soil Permeability inches/hr.	Recommended Application Above rainfall inches/year
Very slow	less than 0.06	12 - 18
Slow	0.06 - 0.2	18 - 24
Moderately slow	0.2 - 0.6	24 - 40
Moderate	0.6 - 2.0	40 - 60
Moderately rapid	2.0 - 6.0	60+
Rapid	6.0 - 20.0	60+
Very rapid	greater than 20.0	60+

* Maximum annual amounts of water that soils could pass are reduced to one-eighth of that which would be possible if summer conductivities could be maintained for 365 days. Half of the reduction is to provide for needed periods of drying, and half is to account for reduced conductivities associated with low temperatures. Actual application rates should also consider crop tolerance and harvest schedules.

TABLE 16 PEAK DAILY MOISTURE REQUIRED *(16)* **, INCHES PER DAY**

Crop	Climate	Net Peak Rate	Irrigation Efficiency Percent		
			80	75	70
Alfalfa, cotton, pasture field corn, sweet corn, soybeans, sugar beets, orchards, citrus	Humid	0.20	0.25	0.27	0.29
	Sub-Humid	0.25	0.31	0.33	0.36
	Semi-Arid	0.30	0.37	0.40	0.43
	Desert	0.35	0.44	0.47	0.50
Grain sorghum, small grains, potatoes, turf grasses, tomatoes, berries, nursery crops, truck crops	Humid	0.15	0.19	0.20	0.21
	Sub-Humid	0.20	0.25	0.27	0.29
	Semi-Arid	0.25	0.31	0.33	0.36
	Desert	0.30	0.37	0.40	0.43

TABLE 18 MOISTURE HOLDING CAPACITY OF SOILS AND CROP ROOTING DEPTHS *(16)*

Soil Texture	Moisture Available for Plant Use, Inches — Crop Rooting Depth, Feet					
	1	1½	2	3	4	5
Sandy	0.5	0.75	1.0	1.5	2.0	2.5
Sandy loam	1.0	1.5	2.0	3.0	4.0	5.0
Silt loam	2.0	3.0	4.0	5.0	6.0	—
Silty clay loam	2.0	3.0	3.5	4.5	5.5	—
Clay and other soils with severe problems	1.0	1.5	2.0	3.0	—	—

Crop Rooting Depths:

1 - 2 feet: Turf grasses, pasture, potatoes, berries, tomatoes, nursery crops, truck crops.

2 - 3 feet: Sugar beets, grain sorghum, small grains, soybeans, sweet corn.

3 - 5 feet: Field corn, alfalfa, cotton, orchards, citrus.

TABLE 17 BASIC INTAKE OF SOIL TEXTURAL GROUPS *(16)*

Soil Texture	Basic Moisture Intake Rate Inches per Hour	
	Bare	Cover
Sandy	1.0	2.0
Sandy loam	0.75	1.5
Silt loam	0.5	1.0
Silty clay loam	0.25	0.5
Clay and other soils with severe problems	0.1	0.2

TABLE 19 MAXIMUM APPLICATION RATES FOR SPRINKLER SYSTEMS INCHES PER HOUR** *(11)*

		0 - 5% Slope* w/cover	0 - 5% Slope* bare
1.	Clay soils throughout; very poorly drained (Alligator, Carlow, Sharkey, Wabash)	.3 "/hr.	.15 "/hr.
2.	Silty surface; poorly drained clay and claypan subsoils Calhoun, Chariton, Edina, Gerald, Mexico, Putnam)	.4 "/hr.	.24 "/hr.
3.	Medium textured surface soils; moderate to imperfectly drained (Bates, Baxter, Eldon, Dundee, Grundy, Lindley, Fullerton, Nixa, Pershing, Seymour).	.5 "/hr.	.30 "/hr.
4.	Silt loams, loams and very fine sandy loams, well to moderately well drained. (Knox, Marshall, Newtonia, Huntington, Nodaway, Sharon).	.6 "/hr.	.4 "/hr.
5.	Loamy sands, sandy loams, or peat soils, well drained (Bertrand, Cass, Dexter, Sarpy).	.9 "/hr.	.6 "/hr.

* Note: Reduce application rates on sloping ground:

Slope	Precipitation Rate Reduction
0 - 5% grade	0%
6 - 8% grade	20%
9 - 12% grade	40%
13 - 20% grade	60%
Over 20%	75%

** Maximum rates are possible only when the soil is dry. Reduce application rates when soils are wet or near saturation in the top one foot of soil.

TABLE 20 TOTAL INCHES TO APPLY TO SOILS IN ONE APPLICATION *(11)*

Soil Type	Root Zone Depth Feet	Net Inches to Apply per Irrigation*
Light Sandy	1	0.50
	2	1.00
	3	1.50
Medium Silt	1	0.85
	2	1.69
	3	2.53
Heavy Clay	1	1.20
	2	2.39

* Based on 50% available moisture in the soil before irrigation.

TEMPERATURE

TABLE 21 AVERAGE MONTHLY TEMPERATURE (2)

°F 1941 - 1970

REGION	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANNUAL
North	27.8	31.8	40.4	54.2	64.2	72.9	77.4	75.9	67.6	57.5	42.7	31.2	53.5
Central	31.4	35.7	43.4	56.6	65.5	73.9	78.2	77.2	69.4	59.2	45.3	34.9	55.9
South	33.5	37.2	44.7	57.3	65.4	73.7	77.5	76.2	68.7	58.5	45.6	36.2	56.2
Bootheel	36.1	39.6	47.4	59.7	68.5	76.7	79.7	78.3	71.1	60.7	48.0	39.3	58.8

TABLE 22 ONE IN TEN YEAR COLDEST AVERAGE MONTHLY TEMPERATURE (2)

°F 1941 - 1970

REGION	Nov.	Dec.	Jan.	Feb.	March
North	37.3	25.4	22.1	28.6	36.8
Central	41.6	30.8	26.4	32.3	38.3
South	42.9	32.0	28.6	31.7	38.6
Bootheel	45.2	34.1	31.4	33.9	42.1

Figure 16

MEAN BEGINNING AND ENDING DATES OF FREEZE FREE PERIOD (17)
1921 - 1950

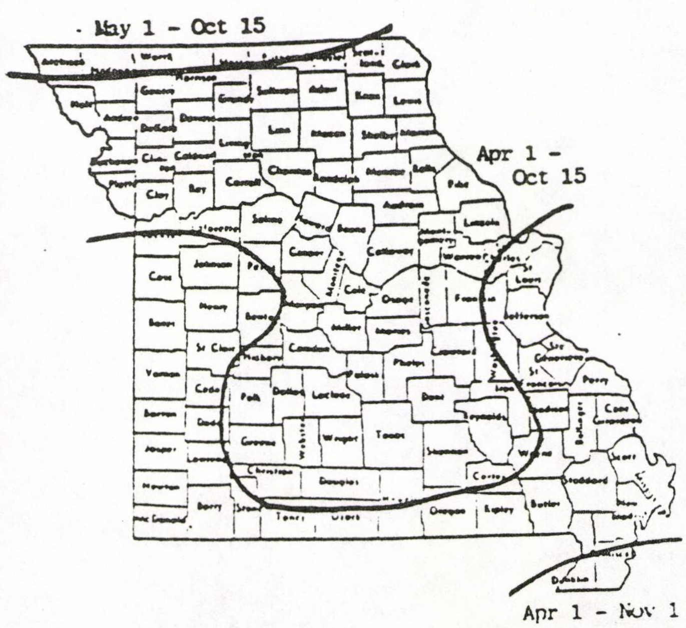
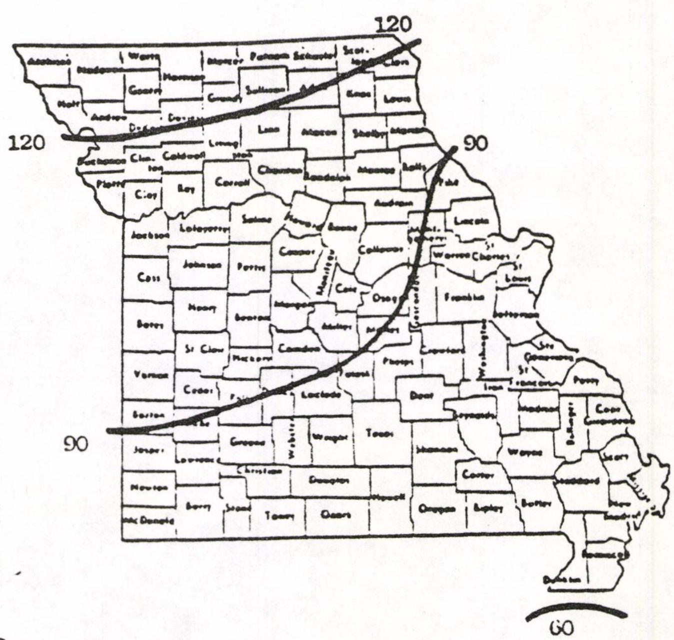


Figure 17

MEAN ANNUAL DAYS MINIMUM TEMPERATURE 32° F (17)
AND BELOW 1930 - 1964



39

Source Numbers Are Shown In Parenthesis ( ) In Text.

SELECTED REFERENCES:

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2. Monthly Averages of Temperature and Precipitation for State Climatic Divisions, 1941 - 1970, National Climatic Center, July 1973.

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9. Rainfall Frequency Atlas for Missouri, MP 336, University of Missouri, 1973.

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11. Missouri Approach to Animal Waste Management, Manual 115, University of Missouri and Mo. Department of Natural Resources, 1979

12. Guidelines For Agricultural Waste Management, Manual 121, Mo. Department of Natural Resources, 1982.

13. Agricultural Waste Management Field Manual, USDA, Soil Sonservation Service.

14. National Bulletin NO.40-0-20, Engineering-Feedlot Runoff, USDA, Soil Conservation Service, 1980.

15. Mineral and Water Resources of Missouri, Missouri Geological Survey, 1967.

16. Traveling Sprinkler Design Guide, Ag Rain Inc., Havana, Ill.

17. Selected Climatic Maps of the United States, National Climatic Center, 1977.

For further information contact: Water Pollution Control Program, P.O. Box 1368, Jefferson City, MO. 65102; phone 314-751-3241 ; Attention Permit Section.

APPENDIX B

LAYNE-WESTERN COMPANY REPORT

Layne

Layne-Western Company, Inc.

WATER SUPPLY SERVICES

WATER WELLS • LAYNE PUMPS • TEST DRILLING • WATER TREATMENT EQUIPMENT

1010 West 39th Street • Kansas City, Missouri 64111 • AC 816 931-2353

April 22, 1970

Lloyd Chain Corporation
Highway 136
Maryville, Missouri

Attention Mr. Norman Craig

Gentlemen:

TEST DRILLING AND WATER SUPPLY WELLS

We have completed the drilling of three (3) test borings and the installation of two (2) water supply wells at your facility on Highway 136 at the east edge of Maryville, Missouri.

Enclosed herewith are copies of our well information sheet giving details of construction of each well and our boring logs for the three (3) test holes drilled.

In addition, we are enclosing our invoice for the completed work.

In an attempt to find a deeper, more reliable aquifer (usually just above bedrock), the first two (2) test borings were drilled to the top of the bedrock surface. No suitable aquifer material was penetrated below a depth of approximately 30' so the third test boring was not drilled to the bedrock surface.

The most suitable aquifer was found in Test Borings No. 1 and 3, at a depth of approximately 20 to 30'. Since this was the only aquifer available, and the best material available, it was decided to install shallow wells at Test Borings No. 1 and 3. The south well, or Well No. 1, was installed at Test Boring No. 1-70. The north well, or Well No. 2, was installed at Test Boring No. 3-70. Well No. 1 was installed to a total depth from ground surface of 30'6" and Well No. 2 a total depth of 27'6" from ground level.

KANSAS CITY • WICHITA • OMAHA • AMES • AURORA • ST. LOUIS • DENVER

A short pumping test was run on both of the completed wells and the results of the pumping test are as shown on the enclosed information sheets.

We would recommend that the pumping rate from Well No. 1 your south well, be limited to 35 gpm. The pump installed in this well, should be set 1' from the bottom of the well or 29'6" from ground level.

Well No. 2, your north well, should not be pumped at a rate greater than 25 gpm. The pump installed in this well, again should be set 1' from the bottom of the well, or 26'6" from ground level.

The above information was given to your plumber, Mr. Bill Jones, by telephone, so that he would know the pumping rates and depths the pumps should be set.

Of course, all our information is based upon the pumping tests we performed and is subject to seasonal variation. During periods of extremely wet weather when the aquifer is receiving good recharge, we would expect the wells could possibly be pumped at greater capacities than recommended, for short periods of time. On the other hand, during extreme drought conditions, the flow from the well may have to be restricted somewhat from the rates we recommend.

We appreciate your confidence in Layne-Western Company in allowing us to do this recent water supply work for you and sincerely hope our workmanship and materials have in every way met with your satisfaction. Should you have any questions regarding any of the information enclosed, or the invoicing of our work, please get in touch with us.

If we may be of further service, please let us know.

Thank you very much.

Very truly yours,

James J. Bridgforth

James J. Bridgforth, P.E.

Layne-Western Company

Contract Name: Lloyd Chain Corporation

No.: KC 633-3 Date: 4/6/70

City: Maryville State: Missouri

TEST HOLE
No. 1-70 fac[illegible] well #1

Driller: J. Harper

Test Hole Location: 15' E. 5' S. of S.E. corner of Building
Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

Static Water Level ______ Measured ______ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
0'0"	1'0"			Brown clay fill
1'0"	5'0"			Dark gray clay, stiff
5'0"	11'0"			Gray clay, stiff
11'0"	20'0"			Dark brown clayey silt, soft
20'0"	22'0"			Gray sandy clay, soft
22'0"	25'0"	water	2"	Gray med. to coarse, some fine sand
25'0"	30'6"	"	5"	Gray med. to coarse, tr. fine sand, gravel
30'6"	80'0"			Gray sandy clay, few boulders, stiff
80'0"	Total depth			

NOTES: Size of Pit 5'0" X 3'6" X 4'0" DEEP

Layne-Western Company

Contract Name: Lloyd Chain Corporation

Job No.: KC 633-B Date: 4/7/70

City: Maryville State: Missouri

TEST HOLE No. 2-70

Driller: J. Harper

Test Hole Location: 7.5" S.W. of s.w. corner of building
Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

Static Water Level ____ Measured ____ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
0'0"	1'0"			Clay fill
1'0"	5'0"			Dark gray clay, stiff
5'0"	10'0"			Light gray clay, stiff
10'0"	19'0"			Gray silty clay, med.
19'0"	21'0"	water)		Gray fine to med. sand
21'0"	25'0"	")	2"	Gray med. to fine, some coarse sand
25'0"	26'0"	"		Gray med. to coarse, tr. TRACE fine sand, gravel
26'0"	61'0"			Gray sandy clay, med.
61'0"	86'0"			Gray sandy clay, stiff
86'0"	90'0"			Gray limy shale, hard
90'0"	Total depth			

NOTES: Size of Pit 4'0" X 3'0" X 4'0" DEEP

Layne-Western Company

Contract Name Lloyd Chain Corporation

[Jo]b No. KC 633-B Date 3/7/70

[C]ity Maryville State Missouri

TEST HOLE factory

No. 3/70 well #2

Driller J. Harper

Test Hole Location 225'0" N. of No. 1-70

Distance and Direction from Permanent Landmark or Previous Test Hole

TEST LOG

Static Water Level ________ Measured ________ Hours After Completion

FROM	TO	MARSH FUNNEL VISCOSITY SECONDS	MUD PIT LOSS INCHES	FORMATION
0'0"	1'0"			Top soil
1'0"	4'0"			Dark gray clay, stoff
4'0"	10'0"			Gray clay, stiff
10'0"	12'0"			Brown & gray silty clay, stiff
12'0"	15'0"			Brown clayey silt, soft
15'0"	19'0"			Gray sandy clay, stiff
19'0"	25'0"	water	6"	Gray med. to coarse, some fine sand
25'0"	27'6"	water	8"	Same tr. fine sand, tr. gravel
27'0"	33'0"			Gray sandy clay, med.

NOTES: Size of Pit 4'0" X 3'0" X 3'6"

APPENDIX C

PHOTOGRAPHS

Photo 1

MW #OW-1 upgradient
(Highway department in upper right hand corner with
steel for heavy equipment closest to well head)

Photo 2

MW #OW-2 downgradient

Photo 3

MW #OW-3 downgradient of surface impoundment

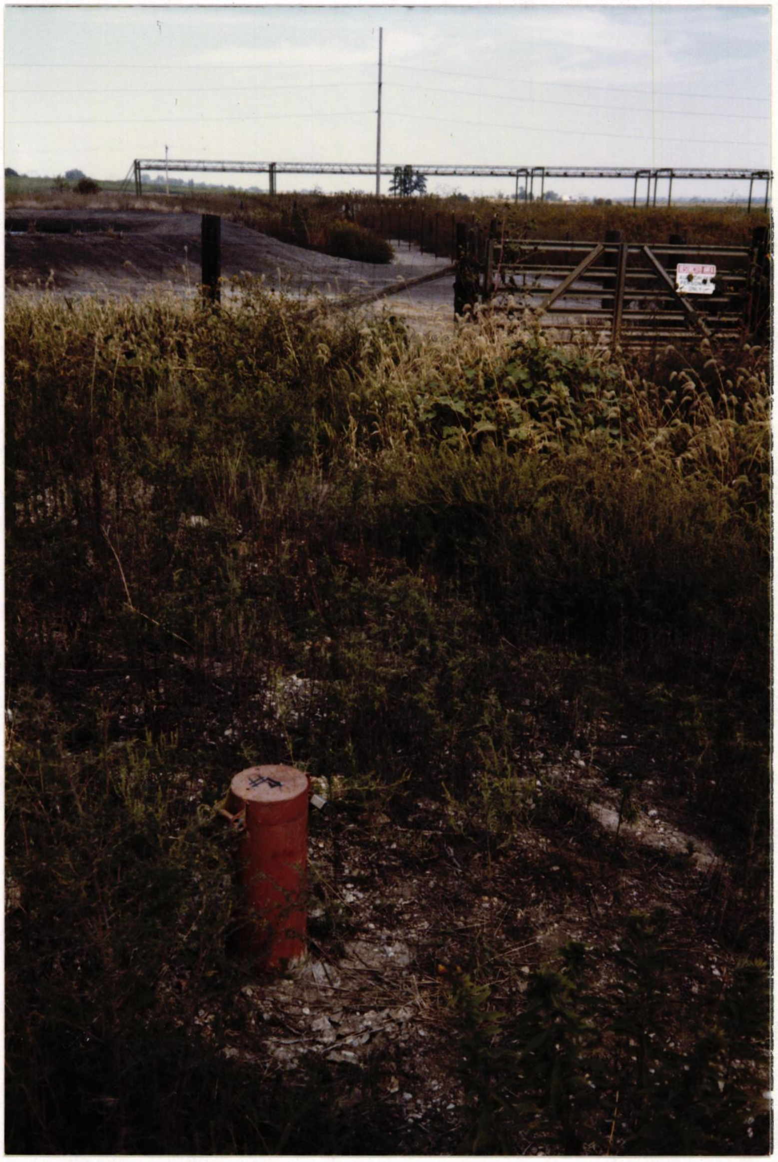


Photo 4

MW #OW-4 downgradient of surface impoundment
(Upper left hand corner is dike of impoundment)

APPENDIX D

OBSERVATION WELL CONSTRUCTION SUMMARY FORMS

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT: Nixdorff-Lloyd Chain Company

SITE: EPA ID# MOD 99238784 Maryville, MO

COORDINATES: SE 1/4, SE 1/4, SE 1/4, SE 1/4 Sec 16, T64N, R35N

DATE COMPLETED: GCA Audit Measurements on 9/21/84

SUPERVISED BY: Benjamin P. Berrios, Paul Turina

WELL NO.: OW-1

AQUIFER: Aquifer One Hundred and Two River Floodplain

GROUND ELEVATION

GENERALIZED STRATIGRAPHY

Brown silty clay

5'

Same materials

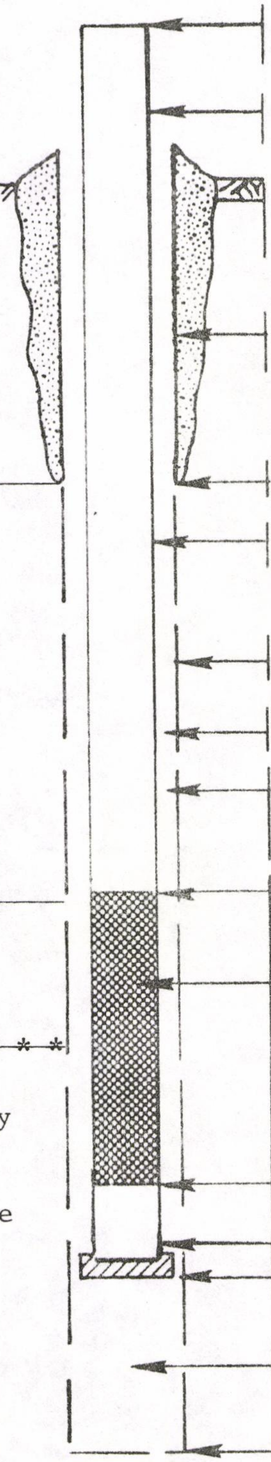
10'

Tan silty clay @ 12.0'

* * * * * * * * * * * *

Water level on 9/21/84 by GCA @ 12.95'

Same as above materials



Elevation of reference point: N/A

Height of reference point above ground surface: N/A

Depth of surface seal: ±5 feet

Type of surface seal: Cement grout broken seal observed

I.D. of surface casing: 6 inch

Type of surface casing: 6 inch diameter schedule 80 steel pipe

Depth of surface casing: ±2 feet

I.D. of riser pipe: 4 inch

Type of riser pipe: 4 inch diameter schedule 40 PVC pipe

Diameter of borehole: 8 inch

Type of filler: Sand

Elevation / depth of top of seal: ±5 feet

Type of seal: Pelletite

Type of gravel pack: Clean 1/2 inch

Elev./depth of top of gravel pack: ±7.7 feet

Elevation / depth of top of screen: ±10 feet

Description of screen: Slotted PVC wrapped with Typar

I.D. of screen section: 4 inch As-built

Elevation / depth of bottom of screen: ±20.5

Elev./depth of bottom of gravel pack: 21.55

Elev./depth of bottom of plugged blank section: N/A

Type of filler below plugged section: 1/2 inch clean gravel

Elevation of bottom of borehole: 21.55

Note ± depth are from as-built details.

GCA CORPORATION
Technology Division

FORM 1002

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT: Nixdorff-Lloyd Chain Company

SITE: EPA ID# MOD 99238784 Maryville, MO

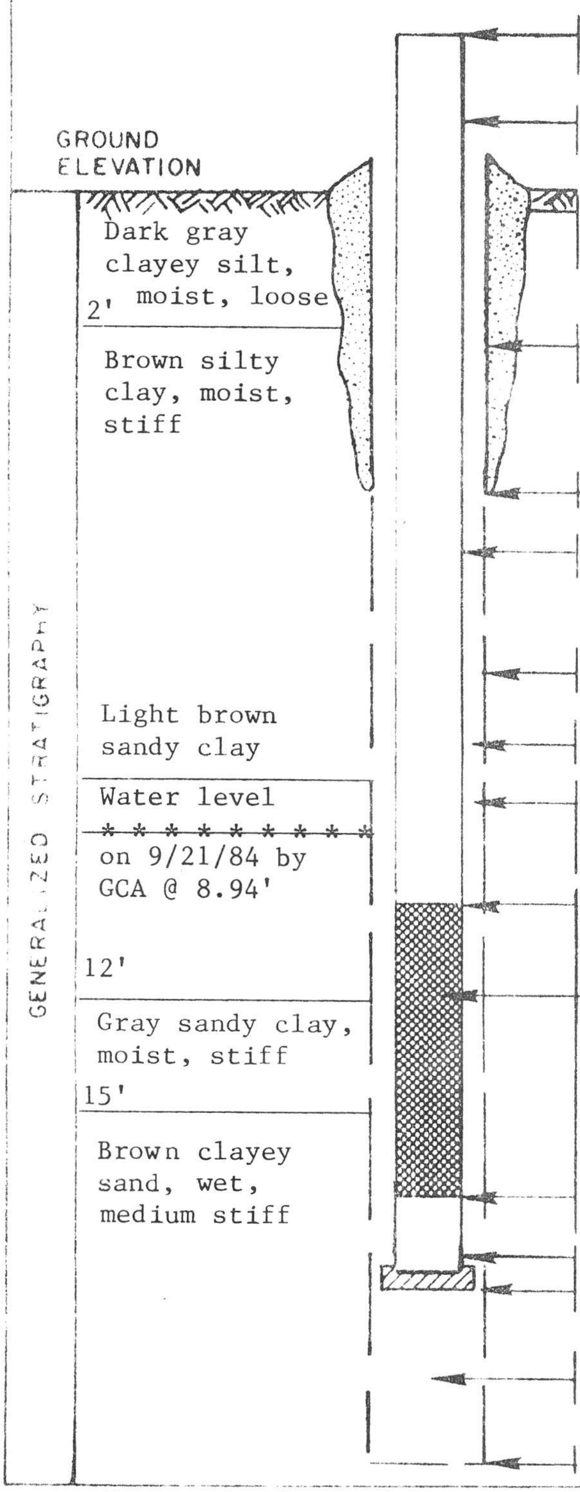
COORDINATES: SE 1/4, SE 1/4, SE 1/4, SE 1/4 Sec 16, T64N, R35N

DATE COMPLETED: GCA Audit Measurements on 9/21/84

SUPERVISED BY: Benjamin P. Berrios, Paul Turina

WELL NO.: OW-2

AQUIFER: Aquifer One Hundred and Two River Floodplain



Elevation of reference point	N/A
Height of reference point above ground surface	N/A
Depth of surface seal	±5 feet
Type of surface seal: Cement grout broken seal observed	
I.D. of surface casing	6 inch
Type of surface casing: 6 inch diameter schedule 80 steel pipe	
Depth of surface casing	±2 feet
I.D. of riser pipe	4 inch
Type of riser pipe: 4 inch diameter schedule 40 PVC pipe	
Diameter of borehole	8 inch
Type of filler: Sand	
Elevation / depth of top of seal	±5 feet
Type of seal: Pelletite	
Type of gravel pack Clean 1/2 inch	
Elev./depth of top of gravel pack	±7.7 feet
Elevation / depth of top of screen	±10 feet
Description of screen Slotted PVC wrapped with Typar	
I.D. of screen section	4 inch As-built
Elevation / depth of bottom of screen	±20.5
Elev./depth of bottom of gravel pack	+20.5
Elev./depth of bottom of plugged blank section	N/A
Type of filler below plugged section 1/2 inch clean gravel	
Elevation of bottom of borehole	22.60

Note ± depth are from as-built details.

GCA CORPORATION Technology Division

FORM 1002

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Nixdorff-Lloyd Chain Company

SITE EPA ID# MOD 99238784 Maryville, MO

COORDINATES SE 1/4, SE 1/4, SE 1/4, SE 1/4 Sec 16, T64N, R35N

DATE COMPLETED GCA Audit Measurements on 9/21/84

SUPERVISED BY Benjamin P. Berrios, Paul Turina

WELL NO. OW-3

AQUIFER Aquifer One Hundred and Two River Floodplain

GROUND ELEVATION

GENERALIZED STRATIGRAPHY

Dark gray clayey silt moist, loose
2'

Brown silty clay, moist medium stiff to stiff

Water level on 9/21/83 by GCA @ 6.15'

8.5'

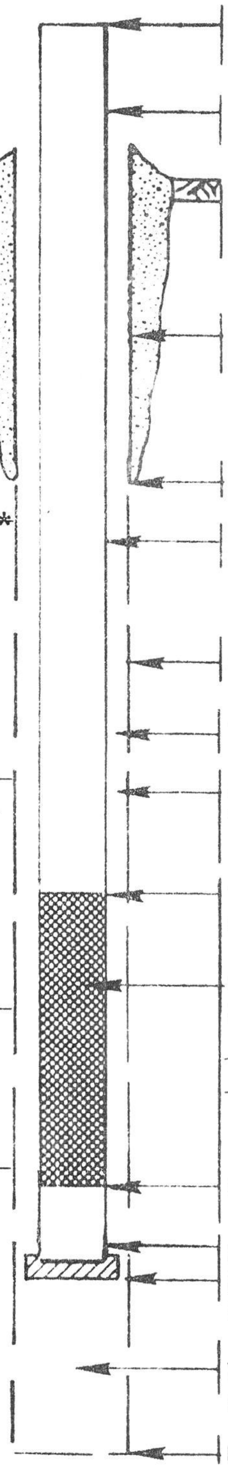
Gray silty sandy clay, moist, stiff

13'

Brown clayey sand, wet, medium stiff

18'

Brown fine to medium sand wet, loose



Elevation of reference point	N/A
Height of reference point above ground surface	N/A
Depth of surface seal	±5 feet
Type of surface seal: Cement grout broken seal observed	
I.D. of surface casing	6 inch
Type of surface casing: 6 inch diameter schedule 80 steel pipe	
Depth of surface casing	±2 feet
I.D. of riser pipe	4 inch
Type of riser pipe: 4 inch diameter schedule 40 PVC pipe	
Diameter of borehole	8 inch
Type of filler: Sand	
Elevation / depth of top of seal	±5 feet
Type of seal: Pelletite	
Type of gravel pack Clean 1/2 inch	
Elev./depth of top of gravel pack	±7.7 feet
Elevation / depth of top of screen	±10 feet
Description of screen Slotted PVC wrapped with Typar	
I.D. of screen section	4 inch As-built
Elevation / depth of bottom of screen	±20.5
Elev./depth of bottom of gravel pack	±20.5
Elev./depth of bottom of plugged blank section	18.25 silted in the well screen
Type of filler below plugged section 1/2 inch clean gravel	
Elevation of bottom of borehole	20.5

Note ± depth are from as-built details.

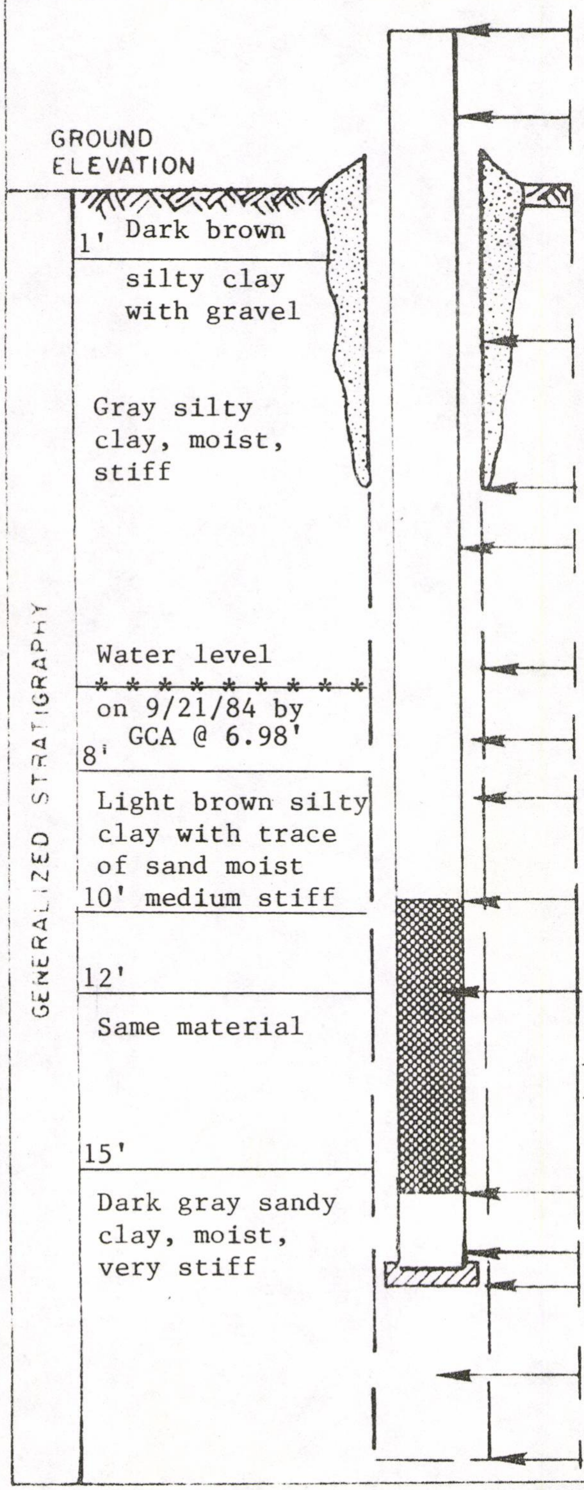
GCA CORPORATION Technology Division

FORM 1002

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT: Nixdorff-Lloyd Chain Company
SITE: EPA ID# MOD 99238784 Maryville, MO
COORDINATES: SE 1/4, SE 1/4, SE 1/4, SE 1/4 Sec 16, T64N, R35N
DATE COMPLETED: GCA Audit Measurements on 9/21/84
SUPERVISED BY: Benjamin P. Berrios, Paul Turina

WELL NO. OW-4
AQUIFER: Aquifer One Hundred and Two River Floodplain



Elevation of reference point	N/A
Height of reference point above ground surface	N/A
Depth of surface seal	±5 feet
Type of surface seal: Cement grout broken seal observed	
I.D. of surface casing	6 inch
Type of surface casing: 6 inch diameter schedule 80 steel pipe	
Depth of surface casing	±2 feet
I.D. of riser pipe	4 inch
Type of riser pipe: 4 inch diameter schedule 40 PVC pipe	
Diameter of borehole	8 inch
Type of filler: Sand	
Elevation / depth of top of seal	±5 feet
Type of seal: Pelletite	
Type of gravel pack: Clean 1/2 inch	
Elev./depth of top of gravel pack	±7.7 feet
Elevation / depth of top of screen	±10 feet
Description of screen: Slotted PVC wrapped with Typar	
I.D. of screen section	4 inch As-built
Elevation / depth of bottom of screen	±20.5
Elev./depth of bottom of gravel pack	±20.5
Elev./depth of bottom of plugged blank section	20.35
Type of filler below plugged section: 1/2 inch clean gravel	slightly silted in the well screen
Elevation of bottom of borehole	20.5

Note ± depth are from as-built details.

GCA CORPORATION
Technology Division

FORM 1002

APPENDIX E

STANDARD OPERATING PROCEDURES

MONITOR WELL PURGING AND GROUND WATER SAMPLING

Purging and Sampling Protocol

Purging and Sampling Methods--Submersible Pump

Objective - Removal of stagnant or otherwise nonrepresentative water from in and around the well casing. The monitoring of pH, temperature, and conductivity of the purge water will typically indicate adequate purged conditions when these monitored parameters show stable readings for a volume equivalent to one well volume.

Alternately, purging will be considered adequate when the water level in the casing falls below the top of the screened interval and an additional volume equal to the volume of the screened interval is removed, or the well runs dry.

Purging Procedures--

When purging a monitoring well, the following procedure will be followed:

- Check location and verify well number.
- Inspect casing for security, maintenance, and integrity.
  - Look for rust or material deterioration;
  - Note condition of surface grouting; and
  - Inspect for signs of inadequate surface water drainage.
- Remove the well cap.
- Measure and record the depth to water using a previously calibrated depth finder. Record the time of measurement.
- Clean depth finder.
- Measure and record the total depth of the well using a weighted stainless steel surveyor's tape. (Note: add length of weight and connection to measured reading.)
- Clean surveyor's tape.

- Determine well volume.

  - Well volume (gallons) = radius x (total depth - depth to water) x 0.163.

- Position plastic sheets around the well.

- Set up submersible pump, bailer, or peristaltic pump according to manufacturer's specification.

- Connect purging cell to the pump outlet tubing.

- Insert pH, conductivity, and temperature probes into purging cell. (All these instruments should be calibrated according to manufacturer's specifications.)

- Place purging cell into a graduated container.

- Lower pump until inlet is at top of well screen or until top of pump is submerged.

- Start purging:

  - Measure and record flow rate;

  - Measure and record pH, temperature, and conductivity; and

  - Note visual characteristics at various time intervals.

- Adjust pump cycle to maintain a constant discharge if possible, however, reduce flow rate as necessary to prevent aeration (see operator's manual).

- Monitor drawdown rate during purging (if possible).

- Terminate purging when:

  - pH, conductivity, and temperature stabilize;

  - Drawdown reaches top of screen; or

  - Well runs dry.

- Record reason for purge termination.

- Record final indicator readings.

- Record visual characteristics.

- Calculate well volumes removed.

- Remove pH electrode from cell and measure pH in purged water container.

Sampling Procedures--

When sampling a monitoring well, the following procedure will be followed:

- Submerge pump to approximately 5 ft below the top of the screen (if possible).
- Adjust sampling rate to approximately 500 ml/min to prevent excessive drawdown.
- Collect sample for volatile organics (purgeables), if required, by slowly following VOA vial down one side to minimize aeration or disturbance. Fill to positive miniscus, carefully close with septum cap. Collect duplicate VOA vials and label.
- Attach in line 0.5 m filter to pump discharge and collect 1-liter sample into Nalgene bottle. Immediately preserve with Ultrex nitric acid to pH 2. Label sample and designate for trace element analysis. Remove in-line filter and discard unless otherwise specified.
- Collect remaining samples as required. Use appropriate container, preserve and label. Record sample collection time with each sample.
- After completion of sampling, record final pH, conductivity, temperature, and depth to water. Complete chain-of-custody/ inventory form.
- Close and resecure well casing cap or other protective/security closure and record final closure time.
- Clean pump and bladder thoroughly with Alconox and D.I. water between wells.

APPENDIX F

GROUND WATER MONITORING REPORT FORMS

GROUND WATER MONITORING REPORT FORM

Name of Facility Nixdorff-Lloyd Chain Co. EPA ID# MOD099238784

Address Highway 136 Maryville, Missouri

Date September 21, 1984

Well ID #OW-1 Picture Exp. # 1 Bearing See map

design: 4" pvc

Total Depth meas: 21.55 Depth to Water 12.95 Total Water (Dif.) 8.60

Casing Inside Dia. 4 inch Water Volume in Casing 5.84 gallons

Depth to top of screen ≅ 10 feet Volume (gal) = TW (ft) x $[r(in.)]^2$ (0.163)

Sampling Method Submersible stainless steel pump with viton bladder

PURGING: Start Time 9:20 (0) Stop Time 10:19 (46 min)

	Init.	2 min	4.5 min	6.5 min	9.0 min	13.5 min	14 min	min	Post Sampling
pH		6.30	6.37	6.53	6.73	6.88	end		
Conduct.		450	460	500	500-525	525	Purge		
Temp.		14	13	13					
Volume							16.36		
Depth to H_2O									

Reason for Purge Termination Stable conductivity, clear sample water

Total Volume Removed 2.25 gallons 0.39 well volumes

RECOVERY:	Init.	14 min	19 min	21 min	23.5 min	28 min	32 min	34.5 min	38 min
Depth	16.36	14.80	14.60	14.45	14.35	14.23	14.19	14.14	

SAMPLE DESCRIPTION initial: clear, some suspended solids

final: clear (mostly)

Well cap & Security very good

Grouting & Drainage cement seal needs repair, mounding away of stand pipe

Accessibility good

COMMENTS Potentially to close to salt piles trucks of highway department for site upgradient well. It may be upgradient enough not to be effected.

GROUND WATER MONITORING REPORT FORM

Name of Facility Nixdorff-Lloyd Chain Co. EPA ID# MOD099238284

Address Highway 136 Maryville, Missouri

Date September 21, 1984

Well ID #OW-2 Picture Exp. # 2 Bearing 351° from OW-3 TN

design: 4" PVC

Total Depth meas: 22.60 Depth to Water 8.94 Total Water (Dif.) 13.66

Casing Inside Dia. 4 inch Water Volume in Casing 9.28 gallons

Depth to top of screen ≅ 10 feet Volume (gal) = TW (ft) x $[r(in.)]^2$ (0.163)

Sampling Method Submersible stainless steel pump with Viton bladder

PURGING: Start Time ______ Stop Time ______

	Init.	__min	__min	__min	__min	__min	__min	__min	Post Sampling
pH									
Conduct.									
Temp.									
Volume									
Depth to H_2O									

Reason for Purge Termination Well not purged

Total Volume Removed ______ gallons ______ well volumes

RECOVERY:	Init.	__min	__min	__min	__min	__min	__min	__min	__min
Depth									

SAMPLE DESCRIPTION initial: ______

final: ______

Well cap & Security good

Grouting & Drainage grouting needs to be rounded away from standpipe

Accessibility good

COMMENTS Silting in not very evident in this well. Probable good development of well performed after installation of screen.

GROUND WATER MONITORING REPORT FORM

Name of Facility Nixdorff-Lloyd Chain Co. EPA ID# MOD 099238784

Address Highway 136 Maryville, Missouri.

Date September 21, 1984

Well ID #OW-3 Picture Exp. # 3 Bearing see map

design: 4" pvc

Total Depth meas: 18.25 Depth to Water 6.15 Total Water (Dif.) 12.10

Casing Inside Dia. 4 inch Water Volume in Casing 8.22 gallons

Depth to top of screen ≈10 feet Volume (gal) = TW (ft) x [r(in.)]^2 (0.163)

Sampling Method Submersible stainless steel pump with viton bladder

PURGING: Start Time 0 min Stop Time 46 min

	Init.	2 min	4 min	6 min	8 min	10 min	13 min	24 min	Post Sampling 32 min	35	45 min
pH		6.47	5.80		5.35	5.40		5.10	5.33	5.00	5.35
Conduct.		650	650		675	675		575	625	610	590
Temp.		17°c			15°						
Volume										9 gal	12 gal
Depth to H_2O				7.30			7.65				

Reason for Purge Termination Sample volume large enough

Total Volume Removed 12 gallons 1.46 well volumes

RECOVERY:	Init.	2.5 min (4.85 since shut off)	5 min	8 min	12 min	16 min	18 min	19 min	min
Depth	—	9.39	7.39	6.80	6.42	6.45	6.21	6.15	

SAMPLE DESCRIPTION initial: turbid, suspended solids

final: same

Well cap & Security good

Grouting & Drainage needs to be mounded sloping away from well

Accessibility good

COMMENTS + 2 feet of silting in of screen resulted in some turbidity, hydraulic conductivity of recovery test is not accurate due to screen filled in with silt.

GROUND WATER MONITORING REPORT FORM

Name of Facility Nixdorff-Lloyd EPA ID# MoD 099238784

Address Highway 136 Maryville Missouri

Date September 21, 1984

Well ID #OW-4 Picture Exp. # 4 Bearing 253.5 from OW-3

design: 4" pvc

Total Depth meas: 20.38 Depth to Water 6.98 Total Water (Dif.) 13.40

Casing Inside Dia. 4 inch Water Volume in Casing 9.10 gallons

Depth to top of screen ≅ 10 feet Volume (gal) = TW (ft) x $[r(in.)]^2$ (0.163)

no sampling performed

Sampling Method Submersible stainless steel pump with viton bladder

PURGING: Start Time ______ Stop Time ______

	Init.	__min	__min	__min	__min	__min	__min	__min	Post Sampling
pH									
Conduct.									
Temp.									
Volume									
Depth to H_2O									

Reason for Purge Termination Well not purged

Total Volume Removed ______ gallons ______ well volumes

RECOVERY:	Init.	__min	__min	__min	__min	__min	__min	__min	__min
Depth									

SAMPLE DESCRIPTION initial: ______

final: ______

Well cap & Security good

Grouting & Drainage grouting should be mounded up and sloping away

Accessibility good

COMMENTS Silting in of well may be occurring slightly if well depth was 20.5 feet as specs show.

APPENDIX G

AUDIT CHECKLISTS

APPENDIX A-1

FACILITY INSPECTION FORM FOR COMPLIANCE WITH INTERIM STATUS STANDARDS COVERING GROUND-WATER MONITORING

Company Name: Nixdorf-Lloyd Co.; EPA I.D. Number: ________

Company Address: Maryville, Miss. 63178; Inspector's Name: Benjamin C. Berrios, Paul Tarina

Company Contact/Official: James Spears; Branch/Organization: ________

Title: Plant Engineer; Date of Inspection: Sept 21, 1984

	Yes	No	Unknown
Type of facility: (check appropriately)			
a) surface impoundment	X		
b) landfill			
c) land treatment facility			
d) storage facility			

Ground-Water Monitoring Plan

	Yes	No	Unknown
1. Has a ground-water monitoring plan been submitted to the Regional Administrator for facilities containing a surface impoundment, landfill, land treatment process, or storage facility?	X		
2. Was the ground-water monitoring plan reviewed prior to site visit? If "No",	X		
a) Was the ground-water plan reviewed at the facility prior to actual site inspection? If "No", explain.			

	Yes	No	Unknown
3. Has a ground-water monitoring program (capable of determining the facility's impact on the quality of groundwater in the uppermost aquifer underlying the facility) been implemented? 265.90(a)	___	X	___
4. Has at least one monitoring well been installed in the uppermost aquifer hydraulically upgradient from the limit of the waste management area? 265.91(a)(1)	X	___	
a) Are sufficient ground-water samples from the uppermost aquifer, representative of background ground-water quality and not affected by the facility, ensured by proper well			
1) Number(s)?	X	___	
2) Location?	X	___	
3) Depth?	X	___	
5. Have at least three monitoring wells been installed hydraulically downgradient at the limit of the waste handling or management area? 265.91(a)	X	___	
6. Have the locations of the waste handling, storage, or disposal areas been verified to conform with information in the ground-water plan?	X	___	___
7. Do the numbers, locations, and depths of the ground-water monitoring wells agree with the data in the ground-water monitoring system program? If "No", explain discrepancies.	X	___	___

	Yes	No	Unknown
8. Has a ground-water sampling and analysis plan been developed? 265.92(a)	X		
a) Has it been followed?	X		
b) Is the plan kept at the facility?	X		
c) Does the plan include procedures and techniques for:			
1) Sample collection?			
2) Sample preservation?			
3) Sample shipment?			
4) Analytical procedures?			
5) Chain of custody control?			
9. Are the required parameters in ground-water samples planned to be tested quarterly for the first year? 265.92(b) and 265.92 (c)(1)	X		
a) Are the ground-water samples analyzed for the following:			
1) Parameters characterizing the suitability of the ground-water as a drinking supply? 265.92(b)(1)	X		
2) Parameters establishing ground-water qaulity? 265.92(b)(2)	X		
3) Parameters used as indicators of ground-water contamination? 265.92(b)(2)	X		
(i) Are at least four replicate measurements obtained for each sample? 265.92(c)(2)	X		
(ii) Are provisions made to calculate the initial background arithmetic mean and variance of the respective parameter concentrations or values obtained from well(s) during the first year? 265.92(c)(2)	X		
b) For facilities which have complied with first year ground-water sampling and analysis requirements:			
1) Have samples been obtained and analyzed for the ground-water qaulity parameters at least annually? 265.92(d)(1)			
2) Have samples been obtained and analyzed for the indicators of ground-water contamination at least semi-annually? 265.92(d)(2)			

	Yes	No	Unknown
c) Were ground-water surface elevations determined at each monitoring well each time a sample was taken? 265.92(e)	X		
d) Were the ground-water surface elevations evaluated to determine whether the monitoring wells are properly placed? 265.93(f)	X		
e) If it was determined that modification of the number, location or depth of monitoring wells was necessary, was the system brought into compliance with 265.91(a)? 265.93(f)			
10. Has an outline of a ground-water quality assessment program been prepared? 265.93(a)			X
a) Does it describe a program capable of determining:			
1) Whether hazardous waste or hazardous waste constituents have entered the ground water?			
2) The rate and extent of migration of hazardous waste or hazardous waste constituents?			
3) Concentrations of hazardous waste or hazardous waste constituents in in ground water?			
b) Have at least four replicate measurements of each indicator parameter been obtained for samples taken for each well? 265.93(b)			
1) Were the results compared with the initial background mean?			
(i) Was each well considered individually?			
(ii) Was the Student's t-test used (at the 0.01 level of significance)?			
2) Was a significant increase (or pH decrease) found in the:			
(i) Upgradient wells			
(ii) Downgradient wells			
If "Yes", Compliance Checklist A-2 must also be completed.			

	Yes	No	Unknown
11. Have records been kept of analyses for parameters establishing ground-water quality and indicators of ground-water contamination? 265.94(a)(1)	___	___	
12. Have records been kept of ground-water surface elevations taken at the time of sampling for each well? 265.94(a)(1)	___	___	
13. Have the following been submitted to the Regional Administrator 265.94(a)(2) :			
a) Initial background concentrations of parameters listed in 265.92(b) within 15 days after completing each quarterly analysis required during the first year?	___	___	
b) For each well, any parameters whose concentrations or values have exceeded the maximum contaminant levels allowed in drinking water supplies?	___	___	
c) Annual reports including:			
1) Concentrations or values of parameters used as indicators of ground-water contamination for each well?	___	___	
2) Results of the evaluation of ground-water surface elevations?	___	___	

APPENDIX B

GROUND-WATER MONITORING SYSTEM TECHNICAL ASSESSMENT

1.0 Background Data:

Company Name: Nixdorff-Lloyd Chain Co.; EPA I.D.#: ______________

Company Address: Maysville, Missouri
63178

____

Inspector's Name: Paul Turina Ben Bernabe; Date: September 2, 1984

1.1 Type of facility (check appropriately):

1.1.1 surface impoundment X
1.1.2 landfill ____
1.1.3 land treatment facility ____
1.1.4 storage facility ____

1.2 Has a ground-water monitoring system been established? (Y/N) Y

1.2.1 Is a ground-water assessment outlined or proposed? (Y/N) Y

If Yes,

1.2.2 Was it reviewed prior to the site visit? (Y/N) Y

1.3 Has a ground-water quality assessment plan been implemented or proposed at the site? (Y/N) Y

If yes, Appendix C, Ground-Water Assessment Plan Technical Assessment must be utilized also.

2.0 Regional/Facility Map(s)

2.1 Is a regional map of the area, with the facility delineated, included? (Y/N) N

If yes,

2.1.1 What is the origin and scale of the map? ______________

____

2.1.2 Is the surficial geology adequately illustrated? (Y/N) N

2.1.3 Are there any significant topographic or surficial features evident? (Y/N) Y

If yes, describe Relatively flat topography between upgradient & downgradient wells, not surveyed to benchmark.

2.1.4 Are there any streams, rivers, lakes, or wet lands within 0.5 mile of the facility? (Y/N) Y

If yes, indicate approximate distances from the facility 2200 ft N is tributary stream to the Hundred and Two mile river, which is east about approximately 4000 feet.

2.1.5 Are there any discharging or recharging wells within 0.5 mile of the facility? (Y/N) Y

If yes, indicate approximate distances from the facility. The facility operates to groundwater supply wells for process water use ≅ 490 ft & 580 ft to the east & southeast. Q ≅ 35-5 gpm each

2.2 Is a regional hydrogeologic map of the area included? (This information may be shown on 2.1) (Y/N) N

If yes:

2.2.1 Are major areas of recharge/dishcarge shown? (Y/N) ____

If yes, describe. ____

2.2.2 Is the regional ground-water flow direction indicated? (Y/N) ____

2.2.3 Are the potentiometric contours logical? (Y/N) ____
If not, explain. ____

2.3 Is a facility plot plan included? (Y/N) Y

2.3.1 Are facility components (tanks, impoundemnts, etc.) shown? (Y/N) Y

2.3.2 Are any seeps, springs, streams, ponds, or wetlands indicated? (Y/N) N

2.3.3 Are the locations of any monitoring wells, soil borings, or test pits shown? (Y/N) Y

2.3.4 Is the facility a multi-component facility? (Y/N) N

If yes:

2.3.4.1 Are individual components monitored separately? (Y/N) ____

2.3.4.2 Is a Waste Management Area delineated? (Y/N) ____

2.4 Is a site water table (potentiometric) contour map included? (Y/N) N

If yes,

2.4.1 Do the contours appear logical based on topography and presented data? (Consult water level data) (Y/N) ____

2.4.2 Are groundwater flowlines indicated? (Y/N) ____

2.4.3 Are static water levels shown? (Y/N) ____

2.2.4 May hydraulic gradients be estimated? (Y/N) ____

2.4.5 Is at least one monitoring well located hydraulically upgradient of the waste handling or waste management areas? (Y/N) ____

2.4.6 Are at least three monitoring wells located hydraulically downgradient of the waste handling or waste management areas? (Y/N) ____

2.4.7 By their location, do the upgradient wells appear capable of providing representative ambient ground-water quality data? (Y/N) ____

If no, explain. Well casings and their location above mean sea level ~~have~~ not been surveyed to a benchmark ~~[illegible]~~ a map(s) compiled.

2.4.8 By their location, do the upgradient wells appear capable of detecting contaminants emanating from the waste handling or waste management areas? (Y/N) ____

If no, explain ______________________________

3.0 Soil Boring/Test Pit Details

3.1 Were soil borings/test pits made under the supervision of a qualified professional? (Y/N) Y

If yes,

3.1.1 Indicate the individual(s) and affiliation(s): Layne-Western Co. completed process water supply wells (1990) Kansas City Testing Laboratory, John J. Zey P.E. Geotechnical Engineer

3.1.2 Indicate the drilling/excavating contractor, if known

L-W — J. Harper Kansas City Testing Lab John Zey

3.2 If soil borings/test pits were made, indicate the method(s) of drilling/excavating:

- o Auger (hollow or solid stem) ____
- o Mud rotary ____
- o Air rotary ____
- o Reverse rotary ____
- o Cable tool ____
- o Jetting ____
- o Other, including excavation (explain) ____

3.3 List the number of soil borings/test pits made at the site

3.3.1 Pre-existing 3

3.3.2 For RCRA compliance 4

3.4 Indicate borehole diameters and depths (if different diameters and depths use TABLE B-1.1).

3.4.1 Diameter: 8" borehole ; 4" pvc well pipe OW-1-4

3.4.2 Depth: 20.5' OW #1-4

3.5 Were lithologic samples collected during drilling? (Y/N) Y

If yes,

3.5.1 How were samples obtained? (Check method(s))

- o Split spoon ____
- o Shelby tube, or similar ____
- o Rock coring ____
- o Ditch sampling ____
- o Other (explain) ? N/A

INFORMATION TABLE B-1

BORING NO.	DEPTH	DIAMETER

3.5.2 At what interval were samples collected? ? N/A

3.5.3 Were the deposits or rock units penetrated described? (boring logs, etc.) (Y/N) Y

3.6 If test pits were excavated at the site, describe procedures.

4.0 Well Completion Detail

4.1 Were the wells installed under the supervision of a qualified professional? (Y/N) Y

If yes:

4.1.1 Indicate the individual and affiliation, if known KCTL, John J. Zey, P.E. Geotechnical engineer

4.1.2 Indicate the well construction contractor, if known same as 4.1.1

4.2 List the number of wells at the site

4.2.1 Pre-existing 3

4.2.2 For RCRA Compliance 4

4.3 Well construction information (fill out INFORMATION TABLE B-2)

4.3.1 If PVC well screen or casing is used, are joints (couplings):

- o Glued on N/A
- o Screwed on

4.3.2 If well screens are sand/gravel packed, are the sand/gravel packs sealed from the overlying material? (Y/N) Y

If yes, describe:

- o Bentonite seals ~~4~~
- o Cement plugs
- o How thick are the seals? N/A

INFORMATION TABLE B-2

	WELL NO.						
	GROUND ELEVATION						
	TOTAL DEPTH						
WELL CASING	TYPE MATERIAL						
	DIAMETER						
	LENGTH						
	STICK-UP						
	TOP ELEVATION						
	BOTTOM ELEVATION						
WELL SCREEN	DEPTH TOP/BOTTOM						
	TYPE MATERIAL						
	DIAMETER						
	LENGTH						
	SLOT SIZE						
	TOP ELEVATION						
	BOTTOM ELEVATION						
OPEN HOLE OR SAND/GRAVEL PACK	DEPTH TOP/BOTTOM						
	DIAMETER						
	LENGTH						
	TOP ELEVATION						
	BOTTOM ELEVATION						

4.3.3 If "open hole" wells, are the casings sealed in place? (Y/N) ____

If yes, describe how: ______________________________

4.3.4 Are annular spaces filled? (Y/N) Y

If yes, describe:

- o Cuttings backfill ____
- o Cement grout X
- o Other (explain) see as built construction detail

4.3.5 Are there cement surface seals? (Y/N) Y

If yes,

- o How thick? N/A

4.3.6 Are the wells capped? (Y/N) Y

If yes,

- o Do they lock? (Y/N) Y

4.3.7 Are protective standpipes cemented in place? (Y/N) Y

4.3.8 Were wells developed? (Y/N) N/a

If yes, check appropriate method(s):

- o Air lift pumping N/A
- o Pumping and surging ____
- o Jetting ____
- o Bailing ____
- o Other (explain) ____

5.0 Aquifer Characterization

5.1 Has the extent of the uppermost saturated zone (aquifer) been defined? (Y/N) N

If yes,

5.1.1 Are soil boring/test pit logs included? (Y/N) Y

5.1.2 Are geologic cross-sections included? (Y/N) N

5.2 Is there evidence of confining (low permeability) layers beneath the site? (Y/N) Y

If yes,

5.2.1 Is the areal extent and continuity indicated? (Y/N) Y

5.2.2 Is there any potential for saturated conditions (perched water) to occur above the monitored zone? (Y/N) Y

If yes, give details: Wells OW-1 & OW-3 could use a ~~gravel~~ less-sand fill mound away from the well stand pipe to ensure proper drainage.

5.2.3 What is the lithology and texture of the uppermost saturated zone (aquifer)? fine silty clay, some fine-med sands, a 8 foot section of sands and gravel before another silt-clay-sand strata before bedrock.

5.2.4 What is the saturated thickness, if indicated? 20-30 approximately

5.3 Were static water levels measured? (Y/N) Y

If yes,

5.3.1 How were the water levels measured (check method(s)).

- o Electric water sounder X
- o Wetted tape
- o Air line
- o Other (explain) X checked total depth of well and water level with steel tape

5.3.2 Do fluctuations in static water levels occur? (Y/N) Y

If yes,

5.3.2.1 Are they accounted for (eg. seasonal, tidal, etc.)? (Y/N) Y

If yes, describe: Seasonal changes occur but more of impact may be caused by pumping of supply wells at site and potential mounding of local ground water near surface impoundment.

5.4.4 Were horizontal ground-water flow velocities determined? (Y/N) Y

If yes, indicate rate of movement 2-4 ft/day

rough approximation

6.0 Well Performance

6.1 Are the monitoring wells screened in the uppermost aquifer? (Y/N) N

6.1.1 Is the full saturated thickness screened? (Y/N) N

6.1.2 For single completions, are the intake areas in the: (check appropriate levels)

- o Upper portion of the aquifer
- o Middle of the aquifer X
- o Lower portion of the aquifer

6.1.3 For multiple completions, are the intake areas open to different portions of the aquifer? (Y/N) ____

6.1.4 Do the intake levels of the monitoring wells appear to be justified due to possible contaminant density and groundwater flow velocity? (Y/N) N

7.0 Ground-Water Quality Sampling

7.1 Is a sampling (groundwater quality) program and schedule included? (Y/N) N

7.2 Are sample collection field procedures clearly outlined? (Y/N) N

7.2.1 How are samples obtained: (check method(s))

- o Air lift pump
- o Submersible pump
- o Positive displacement pump
- o Centrifugal pump
- o Peristaltic or other suction-lift pump
- o Bailer X

7.2.2 Are all wells sampled with the same equipment and procedures? (Y/N) Y

If no, explain ____

7.2.3 Are provisions included to clean equipment after sampling to prevent cross-contamination between wells? (Y/N) Y

7.2.4 Are organic constituents to be sampled? (Y/N) _____

If yes,

7.2.4.1 Are samples collected with equipment to minimize abosrption and volatilization? (Y/N) _____

If yes,

Describe equipment ____

____

____

8.0 Sample Preservation and Handling

8.1 Have standard sample preservation procedures been followed (filtration and preservation where appropriate)? (Y/N) _____

8.2 Are samples refrigerated? (Y/N) _____

8.3 Are sample holding period requirements adhered to? (Y/N) _____

8.4 Are suitable container types used? (Y/N) _____

8.5 Are provisions made to ship samples under cold conditions (ice packs, etc.)? (Y/N) _____

8.6 Is a chain of custody control procedure clearly defined? (Y/N) _____

8.7 Is a specific chain of custody form illustrated? (Y/N) _____

If yes,

8.7.1 Will this form provide an accurate record of sample possession from the moment the sample is taken until the time it is analyzed? (Y/N) _____

9.0 Sample Analysis and Record Keeping

9.1 Is sample analysis performed by a reputable, certified laboratory? (Y/N) _____

Indicate lab ____

9.2 Are analytical methods described in the report? (Y/N) _____

9.2.1 Are analytical methods approved by EPA? (Y/N) _____

9.3 Are the National Primary Drinking Water Standards tested for? (Y/N) _____

9.4 Are the required groundwater quality parameters tested for? (Y/N) _____

9.5 Are the required Indicators for Groundwater Contamination parameters tested for? (Y/N) _____

9.6 Are any analytical parameters determined in the field? (Y/N) _____

Identify:

- o pH _____
- o Temperature _____
- o Specific conductance _____
- o Other (describe) _____________________

____

9.7 Is a plan included to record information about each sample collected during the groundwater monitoring program? (Y/N) _____

9.7.1 Are field activity logs included? (Y/N) _____

9.7.2 Are laboratory results included? (Y/N) _____

9.7.3 Are field procedures recorded? (Y/N) _____

9.7.4 Are field parameter determinations included? (Y/N) _____

9.7.5 Are the names and affiliation of the field personnel included? (Y/N) _____

9.8 Are statistical analyses planned or indicated for all water quality results? (Y/N) _____

9.8.1 Is an analysis program set-up which adheres to EPA guidelines? (Y/N) _____

9.8.2 Is Student's t-test utilized? (Y/N) _____
If other analysis procedure used, identify _____________________

____

9.8.3 Are provisions made for reporting analysis reports to the Regional Administrator? (Y/N) _____

10.0 <u>Site Verification</u>

10.1 Plot Plan indicating the locations of various facility components, ground-water monitoring wells, and surface water streams, lakes and wetlands.

10.1.1 Is the plot plan used for the inspection the same as in the monitoring plan document? (Y/N) _____

If not, explain ____

____

10.1.2 Are all of the components of the facility identified during the inspection addressed in the monitoring plan document? (Y/N) Y

If not, explain ______

10.1.3 Are there any streams, lakes or wetlands on or adjacent to the site? (Y/N) Y

If yes, indicate distances from waste handling areas Tributary & Hundred and Two mile river are 2200' North and 4000 feet East, approximately

10.1.4 Are there any signs of water quality degradation evident in the water bodies or streams? (Y/N) N/A

If yes, explain ______

10.1.5 Is there any indication of distressed or dead vegetation on or adjacent to the site? (Y/N) N

If yes, explain ______

10.1.6 Are there any significant topographic or surficial features on or near the site? (Y/N) Y

If yes, explain Relatively flat relief: ~~inside~~ site floodplain valley of Hundred and Two mile river.

10.1.7 Are the monitor well locations and numbers in agreement with the monitoring plan document? (Y/N) Y

If no, explain ______

10.1.7.1 Were locations and elevations of the monitor wells surveyed into some known datum? (Y/N) N

If not, explain ______

10.1.7.2 Were the wells sounded to determine total depth below the surface? (Y/N) Y

If not, explain ______

10.1.7.3 Were discrepancies in total depth greater than two feet apparent in any well? (Y/N) Y

If yes, explain OW-3 was silted in 2.25'

10.1.8 Was ground water encountered in all monitoring wells? (Y/N) Y

If not, indicate which well(s) were dry

10.1.9 Were water level elevations measured during the site visit? (Y/N) Y

If yes, indicate well number and water level elevation OW-1; 12.95' below top of casing (all) OW-2; 8.94' btoc, OW-3; 6.15' btoc OW-4

~~If not, explain~~ OW-4; 6.98' btoc

APPENDIX H

STATISTICAL TEST RESULTS

NIXDROFF-LLOYD

SITE : NIXDORFF-LLOYD CHAIN CO. WELL ID: #-1 Upgradient

BACKGROUND VALUES

READING #	pH	diff	diff^2	*CONDUCTANCE	diff	diff^2	**TOC	diff	diff^2	**TOX	diff	diff^2
1st Qrt 1	7.2	0.725	0.526	215	0	0	2.9	-1.175	1.381	42.5	12.3	152.5
2	7.2	0.725	0.526	215	0	0	2.9	-1.175	1.381	42.5	12.3	152.5
3	7.2	0.725	0.526	215	0	0	2.9	-1.175	1.381	42.5	12.3	152.5
4	7.2	0.725	0.526	215	0	0	2.9	-1.175	1.381	42.5	12.3	152.5
2nd Qrt 1	6.1	-0.375	0.141	270	55	3025	3.4	-0.645	0.416	17.25	-12.9	166.4
2	6.1	-0.375	0.141	270	55	3025	3.4	-0.645	0.416	17.25	-12.9	166.4
3	6.1	-0.375	0.141	270	55	3025	3.4	-0.645	0.416	17.25	-12.9	166.4
4	6.1	-0.375	0.141	270	55	3025	3.4	-0.645	0.416	17.25	-12.9	166.4
3rd Qrt 1	5.8	-0.675	0.456	205	-10	100	1.7	-2.355	5.546	20.35	-9.8	96.0
2	5.8	-0.675	0.456	205	-10	100	1.7	-2.355	5.546	20.35	-9.8	96.0
3	5.8	-0.675	0.456	205	-10	100	1.7	-2.355	5.546	20.35	-9.8	96.0
4	5.8	-0.675	0.456	205	-10	100	1.7	-2.355	5.546	20.35	-9.8	96.0
4th Qrt 1	6.8	0.325	0.106	170	-45	2025	8.2	4.175	17.431	40.5	10.3	107.1
2	6.8	0.325	0.106	170	-45	2025	8.2	4.175	17.431	40.5	10.3	107.1
3	6.8	0.325	0.106	170	-45	2025	8.2	4.175	17.431	40.5	10.3	107.1
4	6.8	0.325	0.106	170	-45	2025	8.2	4.175	17.431	40.5	10.3	107.1
			4.910			20600			99.093			2088.4
MEAN	6.475			215			4.0			30		
VARIANCE	0.327			1373			0.0401			5.9200		

*FIRST QUARTER READINGS BASED ON
AVERAGE OF THE OTHER THREE QUARTERS

**THE VARIANCE FOR TOC AND TOX IS AN APPROXIMATION BASED ON THE VARIANCE REPORTED REPORTED FOR EACH OF THE FOUR QUARTERS. THIS APPROXIMATION WAS NECESSARY BECAUSE THE FACILITY DID NOT REPORT THE ACTUAL QUAD-RUPLICATE RESULTS, ONLY THEIR MEAN AND VARIANCE. THE EQUATION UTILIZED FOR THIS APPROXIMATION OF A POPULATION IS DISCUSSED IN "INTRODUCTION TO STATISTICAL ANALYSIS" DIXON, W.J. AND MASSEY, F.J. THIRD EDITION 1969, MCGRAW-HILL. THE EQUATION IS AS FOLLOWS:
VARIANCE=(N1-1)VAR1+(N2-1)VAR2+(N3-1)VAR3+(N4-1)VAR4/(N1+N2+N3+N4)

****

NIXDROFF-LLOYD QUARTER 5

SITE : NIXDORFF-LLOYD CHAIN CO. 8-25-83
WELL ID: #-1 upgradient

NLC VALUES

READING #	pH	diff	diff^2	CONDUCTANCE	diff	diff^2	TOC	diff	diff^2	TOX	diff	diff^2
1	7.0	0	0	460	0	0	2.2	-0.025	0.001	37.0	1.5	2.25
2	7.0	0	0	470	10	100	2.5	0.275	0.076	35.0	-0.5	0.25
3	7.0	0	0	450	-10	100	2.5	0.275	0.076	37.0	1.5	2.25
4	7.0	0	0	460	0	0	1.7	-0.525	0.276	33.0	-2.5	6.25
			0.00			200			0.428			11.00
MEAN	7.000			460			2.2			35.5		
VARIANCE	0.0			67			0.1425			4		

****
WELL ID: #-1 upgradient

	pH	CONDUCTANCE	TOC	TOX
t*	3.670	24.199	-9.218	4.717
Tm	5.841	4.541	4.541	4.541
Tb	2.947	2.602	2.602	2.602
Wb	0.0205	86	0.0025	0.4
Wm	0.0000	17	0.0356	0.9167
Tc	2.947	2.917	4.414	3.983

****

NIXDROFF-LLOYD QUARTER 5

SITE : NIXDORFF-LLOYD CHAIN CO. | 8-25-83
WELL ID: #-2

NLC VALUES

READING #	pH	diff	diff^2	CONDUCTANCE	diff	diff^2	TOC	diff	diff^2	TOX	diff	diff^2
1	6.7	0	0	1250	50	2500	4.8	0.2	.0	32.0	1.3	1.6
2	6.7	0	0	1200	0	0	4.8	0.2	.0	31.0	0.3	0.1
3	6.7	0	0	1150	-50	2500	4.2	-0.4	0.2	30.0	-0.8	0.6
4	6.7	0	0	1200	0	0	4.6	0.0	0.0	30.0	-0.8	0.6
			0.00			5000			0.24			2.75
MEAN	6.700			1200.0			4.6			30.8		
VARIANCE	0.0000			1666.6667			0.0800			0.9167		

****

STATISTICAL EVALUATION | WELL ID: #-2

	pH	CONDUCTANCE	TOC	TOX
t*	1.573	43.941	3.833	0.775
Tm	5.841	4.541	4.541	4.541
Tb	2.947	2.602	2.602	2.602
Wb	0.0205	86	0.0025	0.4
Wm	0.0000	416.667	0.020	0.229
Tc	2.947	4.210	4.325	3.344

****

NIXDROFF-LLOYD QUARTER 5

SITE : NIXDORFF-LLOYD CHAIN CO | 8-25-83

WELL ID: #-3

NLC VALUES

READING #	pH	diff	diff^2	CONDUCTANCE	diff	diff^2	TOC	diff	diff^2	TOX	diff	diff^2
1	6.3	0.000	0.000	680	10	100	1.3	-0.28	0.08	42.0	0.5	0.25
2	6.3	0.000	0.000	670	0	0	1.6	0.02	.00	42.0	0.5	0.25
3	6.3	0.000	0.000	655	-15	225	1.3	-0.28	0.08	42.0	0.5	0.25
4	6.3	0.000	0.000	675	5	25	2.1	0.52	0.28	40.0	-1.5	2.25
			0.00			350.0			0.43			3.00
MEAN	6.300			670			1.58			41.5		
VARIANCE	0.0000			116.6667			0.1425			1.0000		

****

WELL ID: #-3

	pH	CONDUCTANCE	TOC	TOX
t*	-1.223	42.429	-12.547	14.415
Tm	5.841	4.541	4.541	4.541
Tb	2.947	2.602	2.602	2.602
Wb	0.0205	86	0.0025	0.4
Wm	0.0000	29.167	0.036	0.250
Tc	2.947	3.094	4.414	3.384

****

NIXDROFF-LLOYD QUARTER 5

SITE : NIXDORFF-LLOYD CHAIN CO. 8-25-83

WELL ID: #-4

NLC VALUES

READING #	pH			CONDUCTANCE			TOC			TOX		
1	6.3	0.000	0.000	4100	-62.5	3906.25	2.6	-0.05	.00	35.0	-1.50	2.25
2	6.3	0.000	0.000	4050	-112.5	12656.2	2.9	0.25	0.06	38.0	1.50	2.25
3	6.3	0.000	0.000	4250	87.5	7656.25	2.2	-0.45	0.20	35.0	-1.50	2.25
4	6.3	0.000	0.000	4250	87.5	7656.25	2.9	0.25	0.06	38.0	1.50	2.25
			0.00			31875			0.33			9.00
MEAN	6.3			4163			2.7			36.5		
VARIANCE	0.0000			10625			0.1100			3		

****

STATISTICAL EVALUATION

	pH	CONDUCTANCE	TOC	TOX
t*	-1.223	75.384	-7.938	6.000
Tm	5.841	4.541	4.541	4.541
Tb	2.947	2.602	2.602	2.602
Wb	0.0205	86	0.0025	0.4
Wm	0.0000	2656.250	0.027	0.750
Tc	2.947	4.480	4.379	3.900

****

NIXDROFF-LLOYD AUDIT

SITE : NIXDORFF-LLOYD CHAIN CO.
WELL ID: #-1 upgradient

GCA VALUES

READING #	pH	diff	diff^2	CONDUCTANCE	diff	diff^2
1	6.9	0	0	525	0	0
2	6.9	0	0	525	0	0
3	6.9	0	0	525	0	0
4	6.9	0	0	525	0	0
			0.00			0
MEAN	6.880			525		
VARIANCE	0.0			0		

****
WELL ID: #-1 upgradient

	pH	CONDUCTANCE
t*	2.832	33.461
Tm	5.841	4.541
Tb	2.947	2.602
Wb	0.0205	86
Wm	0.0000	0
Tc	2.947	2.602

****
if T* is greater than tc then there has been a change in indicator parameter

T* = (AVGm -AVGb)/((VARm/Nm)+(VARb/Nb))^0.5
Tm = VALUE IN TABLE , (N-1)
Tb = VALUE IN TABLE , (N-1)
Wb = VARb/Nb
Wm = VARm/Nm
Tc = ((WbTb)+(WmTm))/(Wb+Wm)

NIXDROFF-LLOYD AUDIT

SITE : NIXDORFF-LLOYD CHAIN CO

WELL ID: #-3

GCA VALUES

READING #	pH	diff	diff^2	CONDUCTANCE	diff	diff^2
1	5.4	0.000	0.000	590	0	0
2	5.4	0.000	0.000	590	0	0
3	5.4	0.000	0.000	590	0	0
4	5.4	0.000	0.000	590	0	0
			0.00			0.0
MEAN	5.400			590		
VARIANCE	0.0000			0.0000		

****

WELL ID: #-3

	pH	CONDUCTANCE
t*	-7.516	40.477
Tm	5.841	4.541
Tb	2.947	2.602
Wb	0.0205	86
Wm	0.0000	0.000
Tc	2.947	2.602

****

if T* is greater than tc then there has been a change in indicator parameter

T* = (AVGm -AVGb)/((VARm/Nm)+(VARb/Nb))^0.5

Tm = VALUE IN TABLE , (N-1)

Tb = VALUE IN TABLE , (N-1)

Wb = VARb/Nb

Wm = VARm/Nm

Tc = ((WbTb)+(WmTm))/(Wb+Wm)